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ABSTRACT

This book is an energy, electricity, and science resource guide for teachers of grades K-3. The types of energy covered are: coal, oil, natural gas, nuclear energy, renewable energy sources, electricity and food. Thirty-one interdisciplinary energy lessons are the heart of the book. Each lesson is teacher tested and can be incorporated into the agenda for mathematics, social studies, or science instruction. The lesson format highlights all of the information needed to assess at a glance the lesson's place in an instructional program. All the lessons are tied into the National Energy Foundation's conceptual framework for energy education. Each lesson is keyed to a specific energy concept within the framework's broad categories: energy sources, uses and applications of energy, energy forms and conversions, environmental and economic impacts, limits of energy resources and supply, energy future, and energy conservation and management. Contents of each individual lesson are: disciplines addressed (science, art, language arts, etc.); appropriate grade level; time required; concept addressed; activity goal; materials needed; "what to do"; and evaluation idea. Background information is provided to help teachers answer student questions. Activities accompanying the lessons include: quizzes; "lingo" (a form of bingo related to terms); games; puzzles; a play; energy checklists) Fifteen similar activities are included in a section "just for fun." An energy glossary concludes the document. All activities are reproducible for classroom use. (PR)

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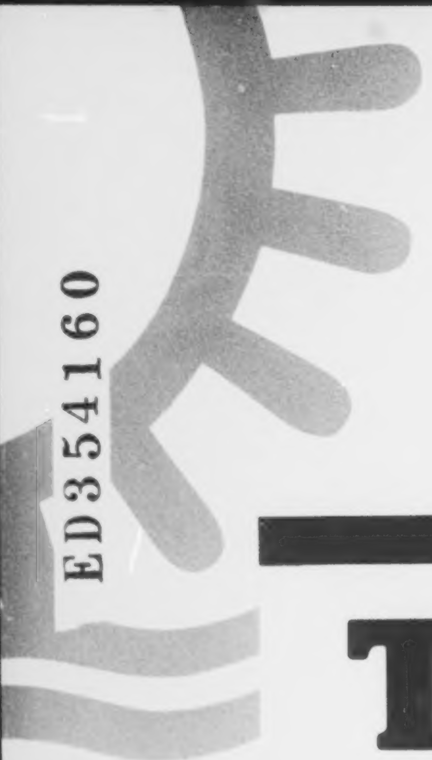

TEACH WITH ENERGY!

Fundamental Energy, Electricity and Science Lessons for Grades 4-6

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TEACH WITH ENERGY!

Fundamental Energy,
Electricity and Science Lessons
for Grades 4-6

THE NATIONAL ENERGY FOUNDATION

The National Energy Foundation (NEF) is a unique nonprofit educational organization devoted to the development of instructional materials and teacher and student educational programs dealing with energy. NEF is supported by resources from business, government, and education. NEF's primary concern is to present energy, science, technology, and contemporary issues accurately and objectively.

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Warning: Some of the activities are potentially hazardous due to the use of flammable substances and/or heat. Please exercise extreme caution. Check your local and state laws governing the use of flammable materials in the classroom. In addition, always be alert to possible electrical hazards. Each school year should begin with a review of the safe use of electricity, and each activity involving the use of electricity should be preceded by a reminder of safety procedures.

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TEACH WITH ENERGY! READ THIS FIRST!

Welcome to Teach With Energy!, an energy, electricity, and science resource guide for teachers of grades 4-6. The pages that follow provide everything you'll need to be comfortable with teaching energy topics all year long. Teacher-friendly features, described below, are built into the book:

Simple, Fun, Idea-Packed Energy Lessons. Interdisciplinary energy lessons, outlined on page 32, are the heart of Teach With Energy!. Each is teacher-tested and can be easily incorporated into the agenda for mathematics, social studies, art, language arts, or science instruction. The lesson format highlights all of the information needed to assess, at a glance, the lesson's place in your instructional program.

All lessons are tied to a conceptual framework. Beginning on page 1, you'll find the National Energy Foundation's conceptual framework for energy education. Developed and refined by teachers over a 12-year period, this framework offers a comprehensive approach to introducing students of all ages to important concepts about energy. Each energy lesson is keyed to a specific energy concept within one of seven broad categories: Energy Sources, Uses and Applications of Energy, Energy Forms and Conversion, Environmental and Economic Impacts, Limits of Energy Resources and Supply, Energy Future, or Energy Conservation and Management.

Background information is at your fingertips. Whether it's "What is nuclear power?" or "How does a light bulb work?" -- we've designed Teach With Energy! to provide you with the answers to the toughest questions your students may ask. The extensive "Energy Basics" (Pages 7 - 29) section and the "Energy Glossary" (Pages 133 - 143) offer in-depth coverage of a wide array of energy and electricity topics.

We've included some activities that are truly "just for fun." In addition to the energy lessons, you'll find simple energy activities at the end of the book (pages 111 - 132) -- just perfect to have on hand for the student who finishes an assignment before the others, to use as a homework page to complete with parents or to add some fun to a rainy day. Enjoy!

Teach With Energy! is reproducible. No need to send away for energy publications. All of the handouts needed for a 4-6 energy unit are included in Teach With Energy! Make as many copies as you need for classroom use.

Let us know how you like Teach With Energy! We'd enjoy hearing from you.

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Conceptual Framework

Sources of Energy

Sources

Program Goal 1: The learner should understand that there are many sources of energy.

Concept 1: The sun is the primary source of the earth's energy.
Concept 2: Natural and human processes are constantly forming energy resources.
Concept 3: Energy sources can be classified in many different ways.
Concept 4: Each source of energy can be used in many ways.

Uses and Applications of Energy

Uses

Program Goal 2: The learner should understand that there are many uses of energy.

Concept 1: All living things and natural processes require energy.
Concept 2: Each form of energy can be used in many ways.
Concept 3: Some human activities and technologies use more energy than others.
Concept 4: Every energy use decision affects standards of living and quality of life.
Concept 5: Laws and regulations are made to control energy development and use.
Concept 6: There are health and safety factors associated with the development and use of energy resources.
Concept 7: Many occupations have resulted from the use of energy sources.

Energy Forms and Conversions

Conversions

Program Goal 3: The learner should understand what energy is and how it can be converted from one form to another.

Concept 1: Energy is the capacity to do work.
Concept 2: Energy occurs in many forms.
Concept 3: All energy conversions are subject to natural laws.
Concept 4: There are man-made and natural energy conversion systems.
Concept 5: The efficiency of energy conversion systems differs.
Concept 6: There are benefits and problems associated with each energy conversion process.
Concept 7: Changes in energy conversion technology have resulted in technological and industrial change.

Environmental and Economic Impacts of Energy

Impacts

Program Goal 4: The learner should understand that the development of energy resources and the use of these resources create impacts on environmental and economic systems.

Concept 1: Energy resource development and use impact environmental conditions.
Concept 2: Industrial societies have a greater impact on the environment than do agrarian societies.
Concept 3: The use or nonuse of an energy source requires environmental and economic trade-offs.
Concept 4: Compromise may be necessary to resolve conflicts concerning the environmental impact of energy use.
Concept 5: Laws and regulations direct the nature and extent of impacts resulting from energy resource development and use.
Concept 6: Economic factors influence energy source discovery, development, distribution and use.
Concept 7: Energy costs are related to the cost of energy resource exploration, recovery, refining, pollution control and transportation.
Concept 8: Energy conservation efforts interact with economic conditions.

Limits of Energy Resources and Supply

Limits

Program Goal 5: The learner should understand that the amount of energy resources and their availability for human activity vary.

Concept 1: Energy resources are unevenly distributed.
Concept 2: High grade (concentrated) energy resources occur in relatively small amounts compared to average and lower grade energy resources.
Concept 3: It takes energy to obtain energy.
Concept 4: All energy resources have limits to their usefulness.
Concept 5: Some energy resources are rapidly renewed while others are renewed so slowly as to be practically nonrenewable.
Concept 6: The availability of the earth's resources and the per capita consumption intersect to determine the limit of the human population the world can support.
Concept 7: The availability of energy resources influences social, political and cultural growth and well-being.
Concept 8: The availability of energy resources is influenced by availability of technology.
Concept 9: Social decisions influence the availability of energy resources.
Concept 10: Economic factors limit energy development and use.
Concept 11: Future technologies may be limited by existing resources.

Energy Future

Future

?

Program Goal 6: The learner should understand that energy sources, technology, and consumption patterns of the future may be different from those of the past or present.

Concept 1: New energy technologies may be developed in the future.
Concept 2: New energy resources may be discovered in the future.
Concept 3: Different consumption practices may alter future demands on energy resources.
Concept 4: Competition for energy resources will influence future relationships between nations.
Concept 5: Energy availability will affect future lifestyles and cultural conditions.
Concept 6: Future energy development will result in the loss of some employment opportunities and the addition of others.
Concept 7: New energy resource technologies are continually being developed.

Energy Conservation and Management

Conservation

Program Goal 7: The learner should understand the value of wise and efficient management practices which extend the useful life of the earth's energy resources.

Concept 1: There are various ways to conserve energy.
Concept 2: Attitudes, beliefs, values and economic conditions influence the practice of energy conservation.
Concept 3: The implementation of energy conservation practices is affected by social and political decisions.
Concept 4: Energy conservation practices affect lifestyles, quality of life and standard of living.
Concept 5: Technological development affects energy conservation options.
Concept 6: Some energy sources are more efficient or convenient for certain uses than others.

Energy Basics

ENERGY BASICS
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The Importance Of Energy

Introduction

Stated simply, energy is the ability to do work or produce change. Like many other normally-occurring facets of our lives, we tend to take energy for granted. But its importance should not be overlooked, because nothing happens without energy.

For example, the act of reading this page requires a complex energy chain. The light which illuminates the words is energy. Energy was necessary to run the machine that printed the page. The ink and paper were produced by energy. It even takes energy to turn these words into meanings in the human mind.

While energy is responsible for making ordinary events such as these possible, its true value is far greater and more basic. In many ways, we depend on energy for our very existence.

Without energy, it would be impossible to produce the food we eat, process and package it, deliver it to stores and, for that matter, consume and digest it.

Similarly, energy is essential to produce warmth, shelter, clothing and other necessities of life. To perform its important work, energy may appear in any of several forms.

What are the forms of energy?

Energy is all around us, all of the time. It may, however, be known by different names, depending on its source. Light, whether it comes from the sun or from a lightbulb, is radiant energy. Gravitational energy is the force which holds objects to the earth. Food and fuel contain stored chemical energy, while objects which are hot contain thermal energy. A machine with moving parts is said to have mechanical energy. Charged objects are filled with electrical energy. And radioactive objects contain nuclear energy.

Another important concept of energy is that it may change forms. Imagine, for instance, that you have a battery-powered robot that sweeps the floor. When you switch it on, it starts to sweep. What happened is that the chemical energy in the battery produced electrical energy in wires, which was converted to mechanical energy in the moving parts of the robot.

What are the sources of energy?

Sunlight, fuel of all types, wind and water are among the list of usable energy sources.

While energy is present in many sources, it may not be working all of the time. Energy in motion is called kinetic energy. Whenever you see something moving or happening, you know that kinetic energy is the force involved. Water flowing over a dam, a person running, a machine in operation are all examples of kinetic energy.

Energy that is not in motion, but could be, is known as potential energy. For example, a piece of firewood contains stored, or potential, energy that is ready to be used.

Without plentiful usable energy sources, life as we know it would grind to a halt.

Is energy important?

Throughout history, the importance of energy has become abundantly clear to developing civilizations. What it comes down to is this: a nation that has many sources of energy is usually highly productive and successful. A nation that can't meet its energy needs has a hard time surviving.

That's why energy conservation and the discovery of new ways to use energy will continue to be major issues of our time. The world is only as safe and secure as its energy supply.

(Adapted from **Energy Readings**, part of the New York Energy Education Project, with permission of the New York Power Pool.)

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Coal

How is coal formed?

Coal is classified by geologists as a mineral. But most minerals, like salt or iron ore, were formed by inorganic matter. Coal, on the other hand, came from organic matter—plants, that lived about 300 million years ago.

During the Pennsylvanian Period in earth's history, the earth was covered with huge swampy forests of giant ferns, reeds and mosses, which grew taller than our tallest trees today. As these plants died and fell into the swamp water, new plants grew to take their place; and when these plants died, still others grew. In time, there was a thick layer of dead, decaying plants in the water.

The surface of the earth also changed and dirt washed into the water covering the dead plants, preventing them from completely decomposing. More plants grew but they too died and fell into the water, forming a separate layer of dead decaying plants, which over time was also covered by sediments, preventing complete decomposition. After millions of years many layers had formed, one on top of the other.

The weight of the overlying layers compressed the lower layers of plant matter forming peat. Heat and pressure, caused by the overlying sediments, produced chemical changes in the peat, forcing out oxygen and hydrogen leaving behind rich carbon deposits—coal.

Geologists estimate that a layer of plants 20 feet thick may have been required to form a coal seam one foot thick. Coal seams vary in thickness, ranging from only a few inches thick to more than 100 feet in thickness.

Where is coal located in the United States?

Coal represents the United States' most abundant energy source. The U.S. Geological Survey has identified 1.7 trillion tons of coal resources in the United States. If yet undiscovered, but likely deposits are added, potential reserves may be as high as 4 trillion tons. The World Energy Conference estimated that the coal reserve of the United States accounts for two-thirds of the free world's total and nearly 28 percent of the total world recoverable coal. By comparison, Saudi Arabia has about 23 percent of the world's proven petroleum reserves.

The United States has about 490 billion short tons of demonstrated reserves, which by definition are potentially mineable on an economic basis with existing technology. At current domestic consumption levels, this is enough coal to last 300 years.

Measurable quantities of coal are found in 36 states, and in 31 states the coal is considered mineable. At present, coal mining occurs in 26 states, including areas of Appalachia, the Midwest, the Central and Northwestern Plains states, the Rocky Mountains and the Pacific Northwest.

How is coal mined?

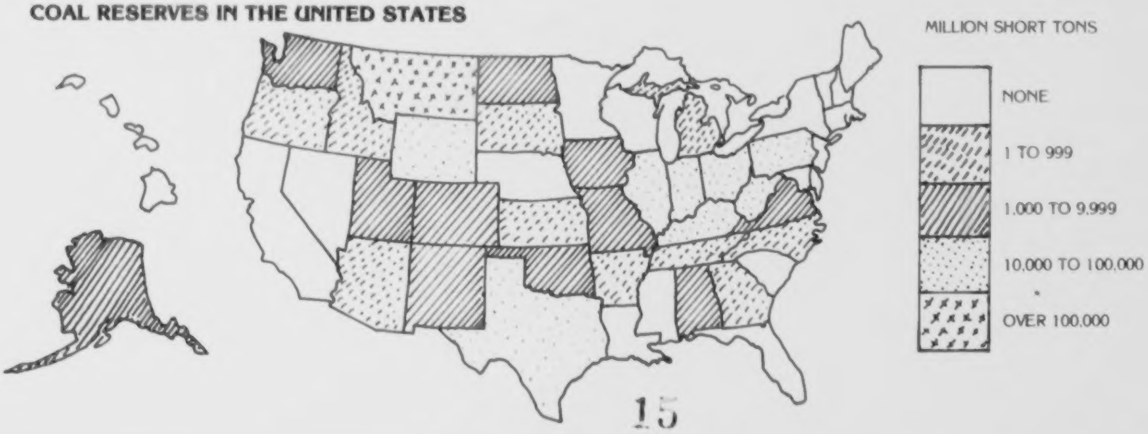
As was the case 50 years ago, most coal is produced from two major types of mines—underground and surface. But the methods for recovering coal from the earth have undergone drastic changes in the past 25 years, as a consequence of technological advances.

Fifty years ago when most coal mining was done manually, underground mines accounted for 96 percent of the coal produced each year. Today, almost 60 percent is produced from surface mines. Most underground mines in the United States are located east of the Mississippi River, although there are some in the West, particularly in Utah and Colorado.

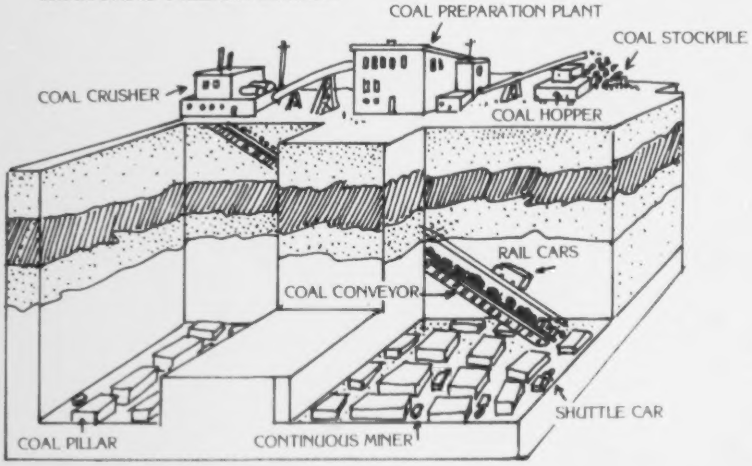
More than two-thirds of the coal produced underground is extracted by continuous mining machines in the room-and-pillar method. The continuous mining machine contains tungsten bits on a revolving cylinder. The continuous miner breaks the coal from the face and then conveys it to a waiting shuttle car which transports it to the conveyor belt to be moved to the surface. No blasting is needed. After advancing a specified distance, the continuous miner is backed out and roof bolts are put in place. The process is repeated until the coal seam is mined.

Another method, called longwall mining, accounts for about 20 percent of production. This method involves pulling a cutting machine across a 400 to 600 foot long face (longwall) of the coal

COAL RESERVES IN THE UNITED STATES



ROOM AND PILLAR METHOD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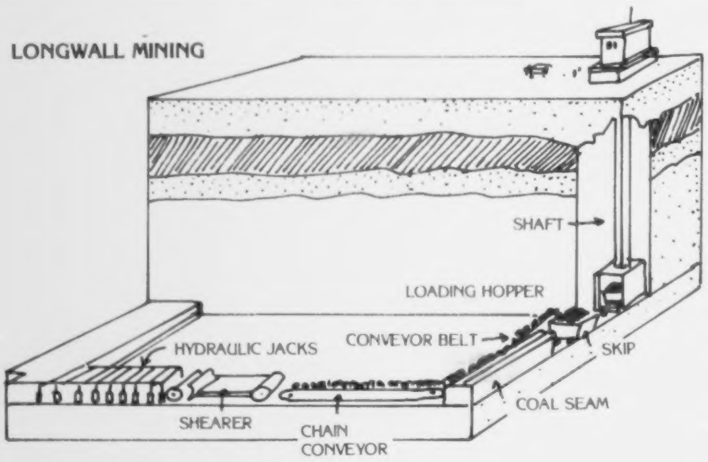
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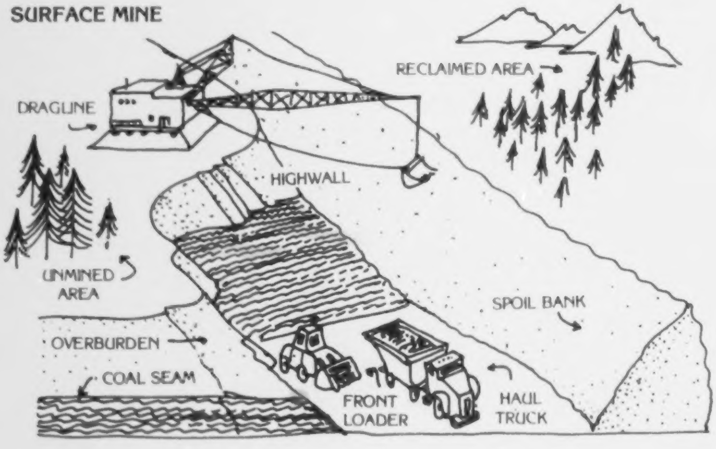
RECLAIMED AREA
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SPOIL BANK
OVERBURDEN
COAL SEAM
FRONT LOADER
HAUL TRUCK

seam. This machine has a revolving cylinder with tungsten bits that shear off the coal. The coal falls into a conveyor system which carries it out of the mine. The roof is supported by large steel supports, attached to the longwall machine. As the machine moves forward, the roof supports are advanced. The roof behind the supports is allowed to fall. Nearly 80 percent of the coal can be removed using this method. The remaining 11 percent of underground production is produced by conventional mining which uses explosives to break up the coal for removal.

Half of the mineable surface coal in the United States is located in the West, but significant amounts are also present in Appalachia and midwestern states. Surface mining is used when the coal seam is located relatively close to the surface, making underground mining impractical.

Before a company can surface mine, it must gather information about the site regarding growing conditions, climate, soil composition, vegetation, wildlife, etc. With this information, the company then applies to the federal government for a permit to mine. The company must post a bond for each acre of land it mines to assure that it will be properly reclaimed.

Most surface mines follow the same basic steps to produce coal. First, bulldozers clear and level the mining area. The topsoil is removed and stored for later use in the reclamation process. Many small holes are drilled through the overburden (dirt and rock above the coal seam) to the coal seam. Each is loaded with explosives which are discharged, shattering the rock in the overburden. Giant power shovels or draglines clear away the overburden until the coal is exposed. Smaller shovels then scoop up the coal and load it onto trucks, which carry the coal to the preparation plant.

Once the coal is removed, the land is regraded to the desired contour and the topsoil is replaced. Native vegetation and/or trees are planted. Coal companies operating surface mines must comply with strict requirements and regulations of the Federal Surface Mining Control and Reclamation Act. A crucial part of the surface mining process is restoring a mined site to acceptable ecological conditions, which means it must be made as productive as it was prior to mining. There are farms, parks, wilderness and recreation areas on what were once surface mines.

The major stigma with the coal industry today is the abandoned or "orphan" mines of the early coal mining years.

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These orphan mines are systematically being reclaimed under the Surface Mining Act. The Surface Mining Act taxes coal producers at the rate of 35 cents a ton for surface mined coal, 10 cents a ton for lignite mined coal, and 15 cents a ton for underground mined coal. The tax is paid to the government and is used to reclaim the orphaned mines.

How is coal used?

Coal has four major markets: electric utilities, industrial/retail users, the steel industry and exports.

Electric utilities use more than 86 percent of the coal produced in the United States. Upon close examination, it is clear that price has been a major deciding factor in coal's increased use. More than 57 percent of the electricity generated in the United States comes from coal.

In an electric power plant, coal, like oil and natural gas, is burned to produce heat. The heat is used to change water into steam. The steam then turns the blades of a turbine, spinning the generator, producing electricity. Before the coal is burned it is crushed and pulverized to the consistency of face powder.

Coal's second largest market is industrial and retail users. Among the industries using coal, the largest consumers are chemical manufacturers, users of stone, clay and glass, paper mills, primary metal industries and the food industry. Industry uses coal as a chemical feedstock to make dyes, insecticides, fertilizers, explosives, synthetic fibers, food preservatives, ammonia, synthetic rubber, fingernail polish, medicines, etc.

The third largest market is the iron and steel industry, where coal is used to make coke. Coke is derived from bituminous coal through heating in airtight ovens. The lack of air prevents the coal from burning and converts some of the solids to gases, leaving coke.

The fourth segment to market is exports. The top five foreign markets are Canada, Japan, Italy, Netherlands and Brazil. U.S. coal distributed to foreign countries in 1988 totaled 95 million short tons (76 million to overseas destinations and 19 million to Canada). Major reasons for the decline in United States' coal exports from the all-time high of 112.5 million tons in 1981 are stiff competition in the international marketplace and worldwide economic conditions.

How does burning coal affect the environment?

Coal is a chemically complex fuel. Whenever it is burned, gases are given off and particles of ash, called "fly ash," are released. The sulfur in coal combines with oxygen to form sulfur dioxide, which can be a major source of air pollution if emitted in large enough quantities.

Today, many of the effects of coal burning have been reduced significantly or eliminated. Three basic methods are used to reduce the quantity of pollutants resulting from coal combustion.

The first, a pre-combustion method for removing contaminants from coal, is coal cleaning or "coal benefication." In coal cleaning the coal is crushed and screened from impurities. Further processing utilizes the different gravities of coal and impurities to separate them in a liquid medium. Coal cleaning can remove the pyritic sulfur, which can reduce sulfur content by as much as 30 percent.

The second, a post-combustion method, uses flue gas desulfurization systems, commonly called scrubbers. According to the Electric Power Research Institute, scrubbers can remove more than 90 percent of the sulfur dioxide emissions from coal combustion. The flue gas is sprayed with a slurry made up of water and an alkaline agent—usually lime or limestone. The sulfur dioxide reacts chemically, forming calcium sulfate or calcium sulfite. This is removed and disposed of as a wet sludge. There are currently 134 scrubbers operated by the electric utility industry in the United States.

The final method for reducing or eliminating pollution from coal combustion is the use of electrostatic precipitators or baghouses which are used to remove fly ash. In electrostatic precipitators the particulate matter is given an electrical charge. The charge attracts it to a collector plate, where the particles are collected, preventing their discharge into the atmosphere. In a baghouse, the particulate matter is filtered out as it passes through a series of filters, similar to a household vacuum cleaner.

The two major environmental concerns today dealing with the use of coal are: increases in atmospheric carbon dioxide levels and acid rain. Much remains to be learned about the relationship between fossil fuels (coal, oil, natural gas) and the environment. It is believed that combustion has partially contributed to the increase in atmospheric carbon dioxide levels. Increased atmospheric carbon dioxide levels may result in warmer climates due to the "greenhouse effect." The increase in atmospheric carbon dioxide prevents heat from escaping from the earth, thus warming the atmosphere.

The combustion of coal also appears to contribute to acid rain, although precise measures of the scope and seriousness of acid rain are not clear or well understood. What is clear is that further study of the phenomenon is necessary.

There is an interesting riddle to the acid rain phenomenon, and that is that acid rain damage has occurred during periods when sulfur dioxide discharges have declined or remained stable (sulfur dioxide is considered to be the principal cause of acid rain).

Notes:

Oil

What is oil?

Oil is naturally occurring and is often referred to as petroleum. Crude oil or crude is unrefined oil or petroleum.

Oil is a mixture of hydrogen and carbon compounds referred to as hydrocarbons. Thousands of different hydrocarbons make up crude oil. The simplest or basic hydrocarbon unit (molecule) is methane or natural gas (CH_4). Hydrocarbons occur as liquids, gases or as solids like gilsonite. The longer hydrocarbon chains are more likely to be liquids.

It is thought that petroleum originated from tiny marine plants and animals (biotic material) that inhabited the earth in prehistoric times. Through time, the tiny marine plants and animals were buried by ocean sand and silt. Over time, the pressure and heat transformed the biotic material into petroleum.

As the biotic material changed from a solid to a gas or a liquid, it began to migrate, being propelled by water or capillary action through the porous marine sediments. In some instances, the petroleum migrated to the earth's surface. Petroleum migrates upward until it is trapped by a non-porous rock structure called a cap. This specific geologic formation is referred to as a "trap." It is these subterranean traps that are sought by the oil industry. Petroleum,then,is associated with porous sedimentary rock layers and fossilized marine life.

How is crude oil refined?

At a refinery, crude oil is distilled or separated into its components or fractions. Distillation involves boiling the petroleum, drawing off the vapors, and then condensing the vapors. The different hydrocarbon compounds that make up petroleum vaporize at different temperatures; thus when they are condensed,they separate out into different fractions. Fractions represent the diverse range of products that can be obtained from petroleum.

How is oil located ?

One of the most accurate exploration methods is seismic technology. In seismic technology, sound waves, created by explosives detonated either on the earth's surface or underground, are sent into the earth and are reflected back by the rock layers. The reflected sound waves are recorded by seismographs. Seismographs are similar to instruments used to measure earthquakes. The reflected sound waves are received by geophones, which transmit the sound waves to a seismograph located in a truck. The particular rate at which the sound waves are reflected create a picture of the underground geology and possible location of oil traps.

Even after the seismic picture is assimilated and analyzed by geophysicists, there is no guarantee of discovering oil. At best, the seismic picture can provide only a guess to what lies beneath us.

Occasionally, oil companies drill for oil in areas where oil or natural gas has not been discovered. Wells drilled in this fashion are known as "wildcat" wells.

What processes are involved in oil drilling?

Before exploration can begin, energy companies need to obtain permits and drilling rights from landowners. Leases might be purchased, or a development agreement reached, with the landowner often receiving royalties if oil is discovered.

Before drilling equipment can be brought on site, preparatory work is required, such as road building, land clearing or housing development for workers.

In 1859, Edwin Drake, a retired railroad engineer, tried to drill for oil. He used a rig that punched or pounded a hole 69½ feet deep. The pounding pulverized the rock and soil, which was removed by flushing the hole with water. Today's primary form of drilling is rotary drilling. Drill bits are used to grind or bore through the rock. As the drill bit is lowered into the earth, pipe stems are added to the top. Drilling usually runs 24 hours per day until the well is completed. The average well today runs a mile deep. On the Overthrust Belt (Utah and Wyoming), it is common to find wells drilled between 8,000 and 15,000 feet deep because of the folded and faulted rock layers.

An important part of the drilling process is the "mud," a mixture of water, clay, and chemical additives which is pumped into the well during drilling. This constantly circulating liquid cools the drill bit and carries debris out of the well. It also prevents the drilled area from collapsing around the drill pipe and serves to control the natural pressures within the well.

Most onshore rigs are portable and include tall derricks that handle the tools and equipment that descend into the well. Offshore drilling may be done from bottom-based platforms, drill ships, or submersible platforms. Each is self-contained with its own set of equipment. Workers and suppliers are ferried by boat or helicopter to the rig.

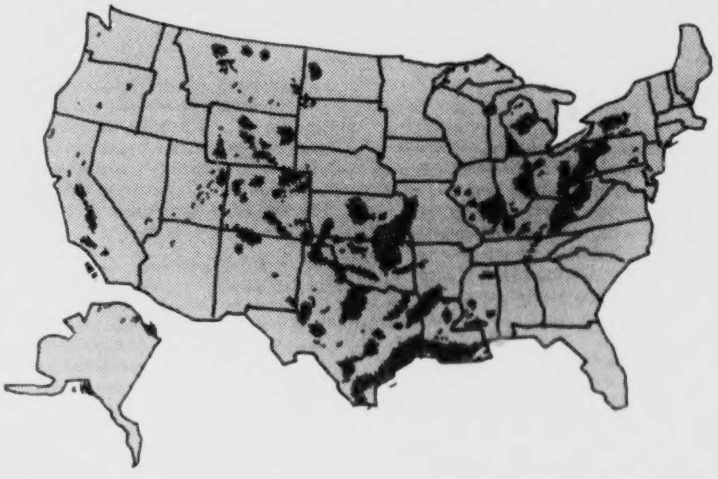
Gushers — what caused them?

After petroleum is discovered, the underground pressure forces it to the surface. The days of the "gushers," when oil would explode to the surface, are gone. Each well contains blowout preventers which automatically shut off the flow of gas or oil should well pressure change, preventing gushers, protecting the environment, and preserving the precious fuel.

How is oil transported to market?

Three-fourths of the domestic crude oil and a third of the refined products in the U.S. are transported by pipeline. Over 1.2 million miles of pipeline connect production sites with refineries and the petroleum market.

Crude from the Overthrust Belt (Utah and Wyoming) is transported by pipeline to refineries serving the Midwest and



OIL AND GAS FIELDS
IN THE UNITED STATES

FROM THE AMERICAN GAS ASSOCIATION

Western markets. Other major pipelines run between Texas and the Northeastern U.S.

Probably the most famous pipeline is the trans Alaska pipeline, which carries crude from the north slope of Alaska, to Valdez in Southern Alaska. The trans Alaska pipeline transports 1.9 million barrels per day, 25 percent of the nation's oil.

Much of the foreign crude used in the United States is brought to American ports by tankers. These "super tankers" are over a thousand feet long and have a capacity to transport more than two million barrels of crude.

On a regional basis, semitank trucks and railroad cars haul petroleum products to consumers or industries that develop and manufacture petroleum-related products.

Where do we obtain oil?

Oil discoveries in the U.S. since the oil embargo in 1973 are numerous. They include the Overthrust Belt of Utah and Wyoming, the Louisiana Trench and its subsequent development into the Gulf of Mexico; and fields off the Texas and California coasts, as well as new fields in Arctic Alaska.

Oil or natural gas is produced in 33 of the 50 states, with Texas still the leader in production. Other top producing states include Alaska, Louisiana, and California.

The largest producers of crude oil and natural gas liquids in 1987 were the U.S.S.R., the United States, and Saudi Arabia.

How is oil used?

Oil has become an integral part of our society. Much of our high standard of living can be traced to the use of petroleum.

At the turn of the century, it was relatively simple to pinpoint the major uses of petroleum. Grease was the major lubricant and kerosene the major illuminant. Coal, eventually to be displaced by petroleum, was the major energy source for heating.

In the 1900s, America became the land of the horseless carriage. The advent of the internal combustion engine to propel the automobile provided a use for what had been a waste product at the refinery—gasoline. Gasoline quickly became an important product of petroleum as automakers adapted engines to utilize this practical fuel.

Today, about 6,000 products are produced, wholly or in part, from petroleum. Among the products derived from petroleum are gasoline, aviation gasoline, jet fuels (highly-refined kerosene), kerosene (now used mostly for cooking, space heaters and farm equipment), diesel fuels (for heavy equipment), fuel oils (for residential and commercial heating, manufacturing processes, and industrial steam and electrical generation), petroleum coke (almost pure carbon which burns with little or no ash), and liquefied petroleum gas (primarily propanes and butanes obtained from refined natural gas). Other products include lubricating oils, greases, waxes, asphalt, nylon stockings, plastics, fertilizers, shoe polish, washing powders, medicines, photographic film, pesticides, insecticides, and waxed paper.

What environmental safeguards exist?

The oil industry is regulated by major federal laws including the Federal Water Pollution Control Act, the Clean Air Act, the National Environmental Policy Act, and the Federal Land Management and Policy Act. These laws govern the amount of emissions that can enter the atmosphere from refineries, the amount of pollutants that can be discharged into waters, roadbuilding, and land restoration after drilling.

Energy companies have been very diligent in making certain they leave a quality environment. But accidents do occur. The 1969 Santa Barbara oil spill, the 1981 Mexico oil spill in the Gulf of Mexico, and the 1989 oil spill near Valdez, Alaska provide examples of the damage that can occur to the environment.

Less obvious environmental damage results from burning petroleum and natural gas.

Automobiles, the primary petroleum consumer in the country, emit carbon monoxide, carbon dioxide, sulfur and nitrogen oxides into the atmosphere from the combustion of petroleum. Industry and homes also emit sulfur when fuel oils are combusted.

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Natural Gas

Introduction

Of the energy sources available, Americans rely on natural gas to supply about 26 percent of their energy needs. This ranks natural gas second in use only to oil which supplies about 43 percent of America's energy needs. Natural gas provides about 42 percent of our industrial needs. Nearly six out of every 10 homes is heated with natural gas and in most cases, is used for cooking, drying clothes, and heating water. Businesses and industries use natural gas in many ways, from cooking in restaurants to fueling high temperature blast furnaces for the manufacturing of steel. In fact, natural gas affects everything we do and use.

What is natural gas?

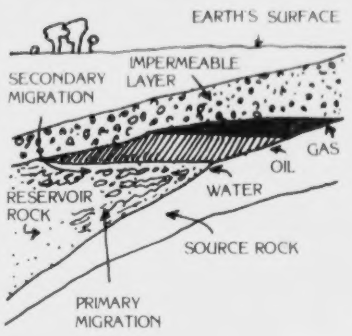
Natural gas has been defined as naturally occurring hydrocarbon and nonhydrocarbon gases found in the porous geological formations beneath the earth's surface. It is made up of about 90 percent methane, with small amounts of ethane, propane, butane, carbon dioxide and nitrogen.

What are the origins of natural gas?

Conventionally, it has been accepted that natural gas is a by-product of the breakdown of marine organisms and/or terrestrial plant debris which accumulated in vast deposits on the bottoms of ancient lakes, rivers and seas. Over time, the deposits were buried by layers of sediment consisting of mud, sand and rock. With each additional layer of sediment the pressure on the organic deposits increased. As pressure and heat from the buildup of sediments increased, chemical changes in the organic deposits took place and a complex, tar-like substance called kerogen was formed. As temperatures continued to increase and the kerogen continued "cooking," more complex compounds of carbon and hydrogen known as oil were formed. Natural gas is generated at the same time as is oil; however, peak generation occurs when oil begins to break down because of high geothermal temperatures, e.g. greater than 205°C (400°F). This range of petroleum (oil and natural gas) generation is called the petroleum window.

As natural gas molecules form, they migrate out of the shaley "source rock" into more porous areas such as sandstone. From there, they eventually make their way to either the earth's surface where they escape into the atmosphere, or they are trapped when their migration path is blocked. In the latter case, impermeable rock layers prevent the molecules from migrating farther and a natural gas accumulation occurs.

NATURAL GAS FORMATION AND ACCUMULATION



In contrast to the biological explanation of the origin of natural gas, the "deep gas theory" speculates that natural gas is derived from non-biological materials that formed the earth billions of years ago. The brainchild behind the deep gas theory is an American named Thomas Gold of Cornell University. In 1979, Gold published the first papers to contend that, "on earth, as on other planets, most hydrocarbons were formed from non-biological sources."

The theory proposes that the earth is made up of primordial materials that combined together in space billions of years ago when the basic structure of the earth evolved. The materials are believed to still be buried far below the earth's crust, where they have been trapped for 4.5 billion years. Cracks and fissures in the earth's crust allow the gases to migrate into reservoirs and to the surface. In this manner, it is believed that the supply of hydrocarbons produced from the primordial material were instrumental in the creation of the earth's atmosphere.

The deep gas theory further proposes that oil molecules are capable of surviving greater temperatures and pressures found tens of miles beneath the earth's surface, and that many of the hydrocarbons that migrate up to the two-to-three-mile depths do in fact break up into methane gas. This would explain the presence of both oil and gas found at two-to-three-mile depths and further theorizes that a much greater supply of oil is present in "deep wells" which range in depth from 50,000 to 60,000 feet and more.

Much of the deep gas theory evolved out of our growing understanding of how the universe and planets are formed, and from information supplied by the space program. For example, when it was learned that many planets contained hydrocarbons in their atmosphere, with little likelihood of ever supporting plant or animal life, the deep gas theory became more credible.

How is natural gas located?

For thousands of years, humans have known of the existence of natural gas and have been able to find it easily in small quantities near the surface of the earth. But as the readily available supplies became scarce, man was forced to search deeper into the earth. By analyzing what was already known about the location and geological formations in which deposits were found, it was determined that natural gas would most likely be found in areas containing source rock, "porous" reservoir rock and favorable trapping mechanisms such as "migration blocks." Based on this knowledge, new methods evolved that would help locate other areas most likely to contain accumulations. At first, fairly simple surface methods including geologic mapping, surveys and aerial photographs where used. But over time more sophisticated methods were developed. Some of the methods used today include: (1) magnetic measurement, a measure of the magnetic field of base rock to determine how much sediment is lying above it; (2) satellite imagery, which helps identify surface structures and patterns that aid in the search for probable underlying hydrocarbon deposits; (3) gravity mapping, which determines thickness of the basin or sedimentary rock layer and helps identify base rock topography; and (4) seismic sound wave reflection, which measures the time to various rock units that reflect acoustic energy. These reflections are plotted in terms of time and amplitude creating a "slice of the earth" view.

Once a trap with economic potential is identified, a drill site is selected. A drill rig is contracted to bore through the layers of rock to the desired level, or "target horizon." The rig uses an engine to turn a table, which turns a pipe that has a drill bit attached on the end. With each rotation of the table, the bit at the end of the pipe digs deeper into the ground. During the process, which generally takes a few weeks, drilling mud (bentonite clay with barite added for weight) is circulated through the drill pipe and well bore. The mud cools and lubricates the bit. It also cleans the hole of cuttings and leaves a thin cake around the well bore to prevent caving of rock fragments and loss of water to the formation. The mud is "weighted" to exceed any expected subsurface pressure. Should a reservoir of natural gas, oil or water that contains higher than expected pressures be encountered, more dense mud is immediately added. If this cannot be done in time, then the well is "shut in" using the surface blowout prevention system. This system is a series of valves that allows the driller several options to close off the well depending upon just how deep the high pressure zone was encountered. The drilling mud is then weighted and circulated through the drill pipe and well bore until the natural gas, oil or water-cut mud is removed and the pressure zone is under control. If the target horizon contains commercial quantities of hydrocarbons (oil and/or natural gas), the well is completed for production. If there is no discovery, the well is plugged and abandoned and the site restored to natural conditions. About one out of eight "wildcats" (wells in unproved areas) result in a significant discovery.

How is natural gas processed and distributed?

Once natural gas has been found, it is necessary to process it and distribute it to users. Hundreds of years ago the Chinese used bamboo to pipe natural gas directly from their wells to their cooking pots. And in the early 1820s William Hart, the first person to develop a practical use for natural gas in America, used hollow logs to bring natural gas from shallow wells to street lamps and small nearby businesses. But as Hart and others continued to pioneer the uses for natural gas, it was found that higher quality natural gas and more functional and durable distribution networks were needed. As a result, hollow logs soon gave way to steel and cast iron pipes. Today, natural gas reprocessing plants are used to turn hundreds of thousands of cubic feet of unrefined wellhead natural gas into commercial, high quality natural gas.

Before natural gas is distributed, it must first be sent to a processing or "stripping" plant where it is cleaned and separated. At the processing plant, the natural gas is first sent through a separator where secondary byproducts including oils, impurities and heavier hydrocarbons such as butane, ethane and propane are removed. Most of these byproducts are reprocessed, packaged and sent to market for a variety of different uses.

As natural gas leaves the processing plant it enters a compressor station where it is pressurized for transmission. As the pressure is increased, the volume of natural gas is reduced and more natural gas can be filled into the same unit space, and the pressure needed to move natural gas through the pipelines is achieved. As natural gas flows through the pipeline, some pressure is lost due to fluid friction caused by the natural gas rubbing against the inside walls of the pipe. This loss of pressure is made up at compressor sub-stations located about every 50-to-100 miles along the transmission pipelines. Along the pipelines are valves used to control pressure and cut off flow in an emergency such as a break in the line or a fire.

During the summer months when peak demands are much lower, natural gas can be stored in empty wells, underground caverns, and in liquified form in storage tanks.

How safe is natural gas?

There are a number of properties of natural gas which make this energy form extremely safe. First, unlike other hydrocarbon fuels, natural gas is lighter than air. This permits it to dissipate into the air if a leak occurs. Other hydrocarbons like propane, ethane and butane are heavier than air and will "puddle" if leaks occur.

Secondly, natural gas has a higher combustion temperature than other fuels. Natural gas ignites at 649°C (1,200°F) compared to as low as 371°C (700°F) for some other fuels.

A third inherent property of natural gas that helps provide a safety barrier is the flammability range previously mentioned. If the exact requirement for mixing natural gas and oxygen are not met, combustion cannot occur.

Although natural gas is safe when properly used, it exhibits certain characteristics that make it potentially dangerous. First, if natural gas and the mixture of oxygen are not properly balanced when lit, incomplete combustion will occur and carbon monoxide will be produced. Second, if a leak occurs and supplants all the available oxygen, asphyxiation may occur.

Because of the potential hazards, it is important that the user know how to safely use natural gas and care for natural gas appliances. One of the first steps to prevent accidents from occurring is to ensure that natural gas appliances and equipment have been properly installed, adjusted, vented and inspected. Other safety precautions that should also be taken include the following:

1. Follow manufacturer's instructions for the installation, operation and maintenance of gas equipment and appliances.
2. Keep flammable materials (paints, solvents, cloth, paper) away from appliances.
3. Provide proper ventilation in areas around furnaces, water heaters, dryers, ranges, etc. Many new appliances use an electronic ignition instead of a pilot light.
4. Perform or have performed routine maintenance on appliances to keep them clean and in proper working order.
5. If the flame goes out, turn the gas off, ventilate the area and notify the natural gas company.

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6. Teach children how to use appliances safely and to recognize the smell of natural gas.
7. When lighting a flame, always strike the match first, then turn on the natural gas.
8. Keep fire extinguishers in the vicinity of appliances with open flames.

If a natural gas leak is detected, the following safety precautions should be taken immediately.

1. Open windows and doors to ventilate the area.
2. Get everybody outside then call the natural gas company or other authorized personnel for assistance. (The telephone call should be made from outside the home. A spark from an electric switch or telephone could ignite the natural gas.)
3. Avoid flames and don't turn on or off electrical equipment or appliances. Never look for a natural gas leak with a lighted flame or match.
4. Your natural gas can be turned off at the valve next to the natural gas meter. A quarter turn of the valve in either direction will shut the natural gas off; the raised part of the valve will then be crosswise to the pipe.
5. If there is only a faint odor, it probably means a pilot light is out on an appliance. Check the pilot lights on all appliances. To relight the pilot light, follow the instructions in the owner's manual. If you still can't find the source or are unsure of how to relight the pilot light, call the local natural gas company.

Notes:

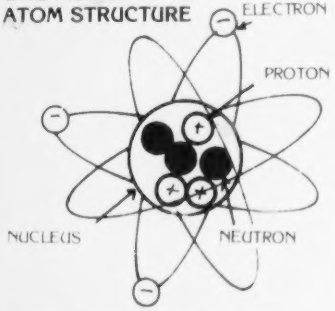
Nuclear Energy

What is nuclear energy?

Nuclear energy is derived from atoms. Atoms are particles that make up matter and are composed of neutrons, protons and electrons. The neutrons and protons are clumped together to form the center or nucleus of the atom, while the electrons orbit the nucleus.

Nuclear energy is the energy inside the nucleus of the atom which binds the nucleus together. A change in the nuclear composition of the atom results in a release of energy.

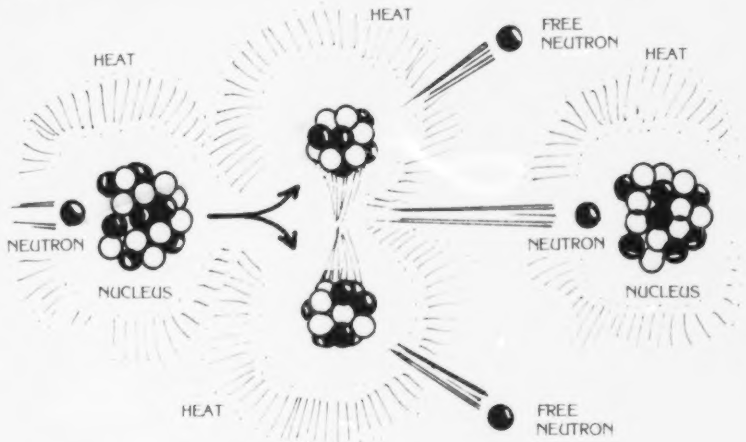
ONE MODEL OF AN ATOM STRUCTURE



How is nuclear energy released from an atom?

Nuclear energy is released from an atom through **nuclear fission** or **nuclear fusion.** In the fission process, commonly used in today's nuclear reactors, a nucleus of a target material such as uranium-235 is bombarded by a neutron which is absorbed. The absorbed neutron causes the atom's nucleus to split apart or "fission" into two atoms of lighter weight, releasing energy, neutrons and radioactivity. Fission, then is the splitting of atoms. Fission reactions produce enormous amounts of heat which turns water into steam for generating electricity. The heat is produced from the collision of fissioned particles with other atoms.

In the second process of releasing energy from the atom, the nuclei of atoms are joined through "fusion," resulting in the creation of a third element, a free neutron, and nucleus. Heat is produced when the free neutron collides with other atoms. The sun and stars get their energy from the fusion of hydrogen to produce helium. Scientists have been attempting to imitate this process for many years, but it requires extremely high temperatures. Although scientists have been unable to develop a container capable of holding such extremely hot material, one of the more promising efforts involves containing the material within a magnetic field, while it is being heated to the required temperature. The United States anticipates the eventual construction of fusion power plants.



What is a chain reaction?

When an atom undergoes fission, heat, neutrons and two lighter atoms are produced. The released neutrons are absorbed by new atoms causing them to fission, releasing more heat and more neutrons. Repeating this process over and over is a chain reaction.

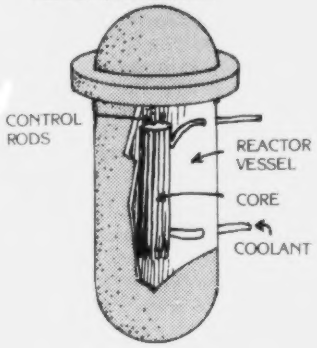
Why do we use uranium?

Uranium, which is naturally radioactive, occurs in nature as either uranium-235 or uranium-238. (The number refers to the element's atomic mass or the number of protons plus neutrons in the nucleus.) Less than 1% of naturally occurring uranium is uranium-235, with more than 99% being uranium-238. It is uranium-235 which fissions, releasing energy. Uranium-238, on the other hand, absorbs bombarding neutrons and is transformed into Plutonium-239, which fissions when struck by neutrons, releasing energy. Thus, the ability of uranium to fission or to be transformed into a fissionable element is why uranium is used in nuclear reactors.

How is fission accomplished in a nuclear reactor?

Nuclear reactors are composed of three principal parts: **reactor vessel, core** and **control rods.** The reactor vessel, a tank-like container weighing more than 500 tons with steel walls, six to nine inches thick, is located at the base of the reactor building. The core, located at the bottom of the reactor vessel, holds the fuel assemblies. Control rods are inserted into the core to regulate the rate of fission. The control rods are able to do this because of their cadmium or boron composition (materials that absorb neutrons). The absorption of neutrons controls the rate of fission. To slow the reaction, the control rods are inserted farther into the core. This decreases the number of neutrons that collide with uranium atoms, thus slowing the reaction. The actual operation of the core involves the consumption of uranium-235, the subsequent creation of fission by-products and the production of plutonium. Energy released by fission is transferred to water, turning it to steam. From this point on, nuclear power plants operate just like fossil-fueled power plants.

REACTOR VESSEL



What is spent fuel?

When the fuel assemblies can no longer efficiently sustain a fission reaction (approximately three years), they are removed from the core. The "spent fuel" as it is called, contains unused nuclear fuel and radioactive nuclear waste. The spent fuel is stored in pools of water at the nuclear power plant, until it can be reprocessed or disposed of. Water is used to cool the fuel and absorb radiation.

How do you isolate and store radioactive waste from land, water and air?

Several methods are being developed to isolate and safely store radioactive nuclear waste. One method proposed includes reprocessing the spent fuel. The used fuel would be transported to reprocessing plants where the still unused nuclear fuel would be separated from the radioactive material that needs to be safely stored.

The low-level or high-level material can be fused into a glass or ceramic solid, which is impervious to air and water, and buried in deep, stable, underground geologic formations. These storage areas would be constantly monitored.

In the future, radioactive wastes will be stored in federal repositories.

What is radiation?

Radiation is a naturally occurring phenomenon which is the result of an imbalance in the number of neutrons and protons in the nucleus of the atom. The imbalance results in an unstable atom, which emits energy or radiation. Three forms of radiation are: alpha particles, which can be stopped by a single sheet of paper; beta particles, which are stopped by a thin sheet of aluminum; and gamma rays, which are stopped by several inches of lead or about three feet of concrete. The intensity of the radiation depends on the speed at which the particle or ray travels. Thus, gamma rays are more radioactive than alpha particles as they travel at a greater speed.

What safety precautions are taken at nuclear power plants?

The Nuclear Regulatory Commission (NRC) is responsible for the regulation of nuclear power plants in the U.S. The NRC goes to great lengths to prevent nuclear accidents. The NRC requires nuclear plant operators to undergo three or more years of extensive training and examination. The NRC also administers strict construction, maintenance and safety regulations.

Nuclear power plants are monitored for radiation and are designed with safety systems which "take control" in event of an accident. Other safety features of nuclear plants are: cooling systems which pump water into the core to keep it cool; the containment building, a large dome-shaped thick-walled steel and concrete building which can prevent the escape of radiation should a problem develop; and an automatic procedure which inserts the control rods into the core to stop the chain reaction.

Because of the dilute quantities of uranium-235 used in commercial nuclear reactors, nuclear explosions are impossible. It requires at least 90% uranium-235 or plutonium-239 to produce a nuclear explosion similar to that of nuclear weapons.

Notes:

Renewable Energy Sources

Introduction

Energy is essential in our society. Energy lights and heats our homes, offices and factories. It powers the machines of industry and transportation. The clothing we wear, the food we eat, the buildings in which we live and work, and even the systems we use to communicate—all depend on energy.

For generations, our society has been enjoying the benefits of plentiful, inexpensive, and easily available energy—fossil fuels. But these fuels, such as coal, oil and natural gas, are finite. As supplies have become scarce and expensive to extract, the search has intensified for alternative energy sources—sources of energy other than fossil fuels.

How is the sun an energy source?

The most obvious and virtually limitless energy source is the natural fusion reactor which the earth revolves around in space—the sun. In terms of humankind's residence on earth, the sun is an object that will last forever, continuously radiating energy that makes life on our planet possible. Although the earth intercepts only a small fraction of the total energy emitted by the sun, the amount received is thousands of times the present energy requirement of the world's human population.

The surface of the sun, which radiates energy in the form of heat and light, is called the photosphere. The sun's interior is composed of dense gases (70% hydrogen and 28% helium) and high temperatures (27 million degrees Fahrenheit/15 million degrees Celsius). The heat and light energy is produced through a thermonuclear reaction (fusion) in which hydrogen atoms are fused together to form helium.

Of the sun's energy that reaches the earth's atmosphere, 30 percent is reflected back into outer space, 47 percent is absorbed by the earth's surface and converted into heat energy, 23 percent drives the hydrological (water) cycle, less than one percent creates winds and ocean currents, and only 0.03 percent is captured by plants and used in photosynthesis. The 0.03 percent of the sun's energy captured by plants provides all the world's food energy and produced the stored fossil-fuel energy (coal, oil, natural gas). Thus, the sun is the primary source of all energy on earth.

The sun's position in the sky has a major effect on the solar energy received by the earth. In order to collect and use solar energy efficiently, one must be knowledgeable of the sun's movements, both daily and seasonally.

What is solar radiation?

Solar radiation is a form of electromagnetic radiation, just as x-rays, light waves, microwaves, television waves and radio waves. However, solar radiation differs from heat flow radiation. This difference is important to solar energy technologies.

First, color is an important factor in solar radiation, but is not in radiation heat flow. Black or dark-colored objects absorb solar radiation and become hotter, while white or light-colored objects reflect solar radiation. Color has no effect on radiation heat flow. Light- and dark-colored objects will absorb the same amount of heat energy from radiation heat flow.

The second most important difference is that solar radiation passes through transparent materials (glass, plastics), whereas radiation heat flow cannot. Thus, transparent materials trap heat energy.

How is the sun's energy harnessed?

Three primary processes exist by which solar energy can be put to practical use: photochemical, photoelectrical, and photothermal. The photochemical process, called photosynthesis, uses solar energy to unite carbon dioxide, water, and nutrients from the soil to create carbohydrates (chemical potential energy) and oxygen. The coal, oil and natural gas we use today probably resulted from photosynthesis that took place eons ago.

In the photothermal process, light energy (shortwave radiation) is transformed into heat energy (longwave radiation). As light energy strikes an object, it is either absorbed, reflected or transformed into heat energy. The heat energy is then either radiated away from the object, carried off by air or water (convection) or conducted to surrounding objects.

Photothermal technologies include: passive and active solar energy systems, power towers and Ocean Thermal Energy Conversion (OTEC) systems.

The photoelectrical process converts light energy into electrical energy. It involves the use of photons (light energy) to excite the outer (valence) electrons of atoms, causing the electrons to move, producing an electrical current. Photoelectric technologies include photovoltaics.

What is wood energy?

Chemical potential energy is produced by plants through photosynthesis and is stored as biomass. The chemical potential energy of biomass is released when the plants decay or are burned.

Wood is one of the most abundant and useful forms of biomass on this planet. Trees are a renewable resource which today cover over 30 percent of the earth's land surface. If 100 million acres of this could be used to produce wood fuel, the United States could reduce its oil consumption by 15 percent, an equivalent of 900 million barrels of oil. Even though trees take 50 to 100 years to reach maturity, we can use this valuable resource forever if we grow and harvest trees with care and planning. In our grandparents' day, wood played a major role as a fuel resource, accounting for 90 percent of the United States' energy supply. In terms of fuel use today, wood accounts for less than five

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percent of the United States' energy consumption.

The most ambitious plan for the use of wood fuel is the "energy plantation." These are large tracts of land devoted to the production of trees for use in nearby electrical generating plants. It is estimated that a 1,000 megawatt plant would require between 200 and 600 square miles of woodland in order to have a sufficient supply of wood fuel.

However, there are problems with large-scale use of wood. Unless the harvesting of trees is done carefully and properly, the soil can become seriously depleted of nutrients and eroded. Also, there are simply too many of us and we want far more energy than our parents or grandparents did; so wood cannot fully satisfy our energy needs. There are also air pollution problems with burning wood in heavily populated areas.

What are biofuels?

Biofuels are derived from plants, which capture the sun's energy and convert it to biomass (chemical potential energy) through photosynthesis. Biofuels are distinguished from fossil fuels, which are also of biological origin, but are non-renewable. Biomass, in the process of being eaten, burned or decayed, transfers its energy to the rest of the living world. There are many proposals for biomass energy plantations. One idea calls for the growing of sea kelp in offshore waters of California and Peru to produce 1.8 billion tons of dry marine algae per year. This biomass would then be converted to methane, which could meet 17 percent of the current United States' natural gas demands. Some farmers are already growing crops to convert into ethanol, which when combined with gasoline makes gasohol. Gasohol is a mixture of 10 percent ethanol and 90 percent gasoline. Gasohol is one way of stretching fossil fuel supplies.

The advantages of biofuels over other fuel sources are: domestic production would have a favorable economic impact, a favorable impact on the environment (biomass is low in polluting sulfur), and the energy produced is renewable. There are, however, problems with the energy plantation concept; large land areas would be converted to single crop stands which are susceptible to disease and pest outbreaks; by centralizing energy production, the energy plantation requires elaborate electricity transmission grids.

How is refuse an energy source?

One type of biomass that has potential as an energy source is organic waste or refuse (garbage). Although still considered a problem rather than a resource, there is little doubt that refuse will be used more and more as raw materials for conversion and recycling. Refuse can also be converted to other useful forms by composting (decaying organic materials in carefully constructed piles to produce a soil conditioner and fertilizer) or anaerobic digestion (decaying organic material in airtight containers to produce methane, liquid fertilizer, or distilled to produce ethanol). However, we must remember that it takes energy to produce the items that become our refuse. Conservation — using less paper, plastics, fabrics, aluminum, etc. — saves more energy than conversion and recycling.

How is wind an energy source?

Wind is a form of kinetic energy created in part by the sun. About two percent of the sun's energy that reaches the earth is converted to wind energy. The atmosphere is heated during the day by the sun and at night it cools by losing its heat to space. Wind is the reaction of the atmosphere to the heating and cooling cycles, as well as the rotation of the earth. Heat causes low pressure areas, and the cool of the night results in high pressure areas. This process creates wind when air flows from high pressure areas into low pressure areas.

Wind energy has been used for hundreds of years. The windmills of Europe and Asia converted the kinetic energy of the wind into mechanical energy, turning wheels to grind grain. Today wind-driven generators are used to convert the kinetic energy of wind into electrical energy. Wind-driven systems consist of a tower to support the wind generator, devices regulating generator voltage, propeller and hub system, tail vane, a storage system to store electricity for use during windless days, and a converter which converts the stored direct current (DC) into alternating current (AC).

In the year 2000, wind could generate from seven to 10 percent of the total electricity produced in the United States. Farms in rural areas across the nation already find wind generators a viable energy supplement. However, the cost of a wind system that provides energy at our present rate of consumption is expensive for a single family. The most ambitious proposals to harness wind power involve the construction of wind "farms" where hundreds of wind turbines will produce electricity.

The main problem with wind energy is that it is not constant or predictable, it has a load factor of only 25 percent and is only 35 percent efficient. Many areas do not have enough wind to make generation feasible, while some locations are susceptible to gales which would destroy or damage the system. Icing can also be a problem in cooler climates. Wind systems also take up large areas and can be quite noisy. If these problems can be overcome, wind energy could be an optimum energy alternative, due to the fact that it is renewable and environmentally safe.

What is hydropower?

Hydropower is a form of solar energy. The sun's energy drives the hydrologic cycle by evaporating water from lakes and oceans and by heating air. The hot air then rises over the water carrying moisture to the land. The cycle continues when the water falls as precipitation and flows back to lakes and oceans.

The potential energy of water located at elevations above sea level is one of the "purest" forms of energy available. It can provide energy without producing pollution. It is relatively easy to control and can be converted to electricity with an efficiency of 75-85 percent. As a result, large and small rivers around the world with the appropriate topography have been dammed and waterwheels and water turbines installed to capture the kinetic energy of the falling or flowing water.

Hydroelectric installations require the construction of dams to increase the reliability of the energy available from a

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stream. The dam also regulates the flow of water and creates water pressure at the bottom of the dam. The water pressure is proportional to the depth of the reservoir created by the dam. The greater the water pressure, the greater the power.

Water from the reservoir flows through the dam in pipes called penstocks to the powerhouse. In the powerhouse the water pressure is applied to a turbine which spins a generator to produce electricity. After the water has moved through the turbine, it is released into the river below the dam.

Hydroelectric power is cost-effective and proven. However, there are drawbacks. The damming of a river or stream has a critical and sometimes irreversible impact on the long-term ecological balance of that river or stream. Dams also encourage an accumulation of silt and can be a hazard in earthquake zones. However, dams create a better environment for some animals and plants, provide new recreational areas, and can control natural disasters such as floods and erosion.

How are ocean tides an energy source?

The potential energy of gravity—caused by the relationship between the earth, moon, and sun—and the kinetic energy of the earth's rotation create tides and the kinetic energy associated with their rising and falling. The key to the usefulness of tidal energy is the height difference between high and low tide.

In order to obtain energy from tides a dam must be constructed across a coastal inlet. The dam allows water to flow inwards at high tide, trapping the water. At low tide the water is allowed to flow back through the dam in a penstock. The flowing water turns a turbine and generator, producing electricity.

There are only a few locations in the United States that would be suitable for tidal energy development. In addition to the environmental concerns, there are technical and economic problems that will have to be worked out before tidal energy is feasible.

How are ocean waves an energy source?

The kinetic energy of waves is derived from the interactions of winds and ocean currents. Methods for harnessing the kinetic energy of waves are new and untested. Several different devices have been successful on a small-scale operation. All of them operated by using the natural up-and-down motion of waves. For example, the Madsuda buoy consists of an upturned canister with two holes in the top portion of the container floating in the water. As the waves rise and fall inside it, air is forced in and out by air pressure. The stream of air drives an air turbine, which, in turn, drives a generator producing electricity.

Waves, like wind, are unpredictable. Also, the environmental impact of any proposal would have to be carefully studied. Presently, wave energy is not economically feasible.

What is geothermal energy?

Geothermal energy, heat from within the earth, is the result of radioactive decay, chemical reactions, friction from the movement of crustal plates, and heat present from the earth's formation.

There are three basic forms of geothermal energy: hydrothermal, geopressurized, and hot dry rock. Hydrothermal systems are composed of hot water and steam trapped in porous or fractured rock near the earth's surface. Geopressurized reservoirs contain a mixture of hot water and methane gas trapped in sedimentary rock far beneath the earth's surface. Hot dry rock formations contain abnormally hot rock and little water.

Most of the recoverable United States geothermal reserves are located within the Western states: Alaska, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Washington.

All geothermal energy sources can be used in industrial processes and space heating, but only hydrothermal resources can be used in electrical generation. Hydrothermal resources use steam directly to turn a turbine and generator to produce electricity. In the process, steam is converted to water in a condenser and returned to the earth.

Direct application of geothermal energy to heat buildings can be found in Reykjavik, Iceland; Klamath Falls, Oregon; and Boise, Idaho. Electricity is produced by geothermal energy in only two locations in the United States: Pacific Gas and Electric Company's field at the Geysers in California, and Utah Power and Light Company's field near Milford, Utah.

Environmental and maintenance problems arise when the hot geothermal water, saturated with soluble minerals, cools and deposits the minerals in pipes and equipment. Geothermal energy, because of its localization, cannot satisfy the United States' overall energy needs.

Notes:

Electricity

Introduction

Electricity is a secondary energy source, that is, it is generated from the conversion of a primary energy source—solar, oil, coal, natural gas, or nuclear. Electricity is unique, as it is energy in transit, kinetic energy, obtained when electric charges are set in motion by an electromotive force.

But to most people, electricity is the cause of lightning, or the form of energy that powers their television set and lights their home. They have a limited understanding of the scientific principles and technologies required to generate, transmit, use, and manage electricity.

What is the atomic structure of matter?

Since the time of the ancient Greeks, matter has been thought to be made up of atoms ("atom" is the Greek word for "indivisible"), though the Greek ideas about the nature of these "indivisible" particles were rather vague. Through the work of Niels Bohr, Lord Rutherford and others it was revealed that atoms actually have a complex structure.

According to Bohr's theory, an atom consists of a positively charged nucleus, surrounded by negatively charged particles, called electrons. The nucleus of an atom consists of two fundamental particles: protons and neutrons. The proton carries a positive charge while the neutron has no charge.

The positive charge of a proton is equal to the negative charge of an electron. Since atoms ordinarily are electrically neutral, the number of positive charges equals the number of negative charges — that is, the number of protons in the nucleus is equal to the number of electrons surrounding the nucleus.

What are ions and ionization?

An ion is an atom that has become electrically unbalanced by the loss or gain of one or more electrons. When an atom loses an electron, its remaining electrons no longer balance the positive charge of the nucleus, and the atom acquires a positive charge. This atom is called a cation. Similarly, when an atom gains an electron, it acquires a negative charge and is called an anion. The process of producing ions is called ionization.

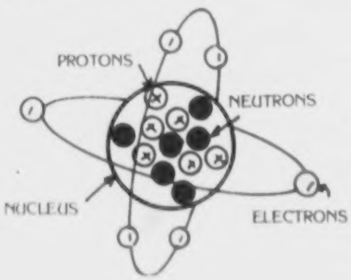
Ionization does not alter the chemical properties of an atom, but it does produce an electrical charge. Ionization can be brought about by the collision of electrons or by exposure to radiation. This is because the electrons in the outermost shell of an atom are held rather loosely and, hence, can be dislodged easily.

What are free electrons, conductors and insulators?

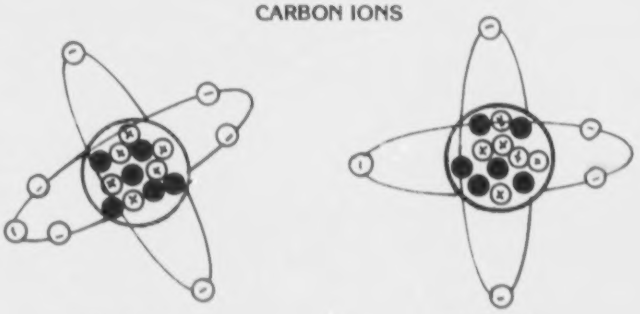
Electrons that have been "knocked" out of the outer shell of an atom are known as "free" electrons. These free electrons can exist by themselves outside of the atom, and it is these electrons which are responsible for most electrical phenomena. The movement of free electrons constitutes an electric current.

All substances normally contain free electrons that are capable of moving from atom to atom. Metallic materials, such as silver, copper, or aluminum, contain numerous free electrons capable of carrying an electric current and are called conductors. Non-metallic materials, which contain few free electrons, are called insulators. Materials that have an intermediate number of free electrons available are classed as semiconductors. The more free electrons a material contains, the better it will conduct electricity.

A CARBON ATOM



CARBON IONS



NEGATIVE ION
(ANION)

POSITIVE ION
(CATION)

What is electric current?

The free electrons in a conductor are ordinarily in a state of chaotic motion. However, when an electromotive force (or voltage) is applied, such as that provided by a battery or electric power plant generator, the free electrons in the conductor are guided in an orderly fashion, atom to atom. This orderly motion of free electrons under the influence of an electromotive force is called an electric current. Although electrons drift through the wire at a relatively slow speed, the disturbance or impulse is transmitted almost at the speed of light. The electron current continues to flow through the conductor as long as the electromotive force is applied. The conductor itself remains electrically neutral, since electrons are neither gained nor lost by the atoms within the conductor. What happens is electrons enter the conductor from one end and an equal number of electrons are given up by the other end of the conductor. Thus, the free electrons present within the conductor act simply as current carriers.

Electric current is the transport of electric charge (electrons). Electric current is measured in amperes and is the amount of electrons passing a given point in one second. An ampere is equal to about 6.25×10^{18} electrons per second.

Voltage on the other hand is a measure of potential difference, the electromotive force necessary to move electrons through conductors. The amount of electric current moved through a conductor by the voltage is influenced by the conductor's resistance.

Electric power, the rate at which work is performed by moving electrons (electric current), is measured in watts and is determined by multiplying the current by the voltage:

$$1 \text{ watt} = 1 \text{ amp} \times 1 \text{ volt}$$

Because of the relationship between electric current and voltage to perform work, the same amount of work can be performed with either a high current and low voltage or a low current and high voltage.

What is resistance?

The opposition to the flow of free electrons in a material is called resistance. The resistance of material dissipates energy in the form of heat, because of friction between the free electrons and atoms of the material. As the material is heated, more collisions occur and the resistance to the flow of electric current increases.

The resistance of electrical conductors depends on their dimension and on their composition. As the cross-sectional area increases, the resistance decreases; but as the length increases, the resistance rises. A long, thin conductor, therefore, has more resistance than a short, thick one with the same volume of material. Silver has less resistance than copper, whereas aluminum and iron have more.

Although the same voltage may be applied to a light bulb and an electric iron, the actual current flow is different in each, because each has a different resistance. So not only does the voltage determine how much current flows through an electrical appliance but also the resistance of the appliance. The relationship between resistance (R), voltage (V), and current (I) then, can be expressed by the mathematical formula: $I = V/R$. The unit of measure for resistance is the Ohm, which is named after George Ohm who was the first person to specify the relationship between resistance, voltage, and current. It is this resistant property of conductors which is used to produce light or heat from electricity.

What is static electricity?

When certain materials are rubbed together, free electrons are transferred by friction from one to the other, and both materials become electrically charged. These charges are not in motion but reside statically on each material, and hence this type of electricity is known as static electricity. We've all had experience with static electricity: lightning during a storm; sparks flying after we shuffle over a rug; hair standing up on end after brushing — all these are typical examples of the effects of static electricity. This type of electricity is produced by friction.

What is thermoelectricity?

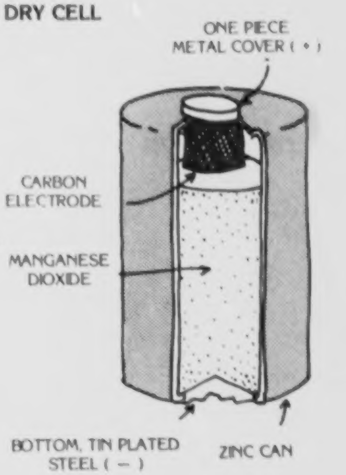
When two dissimilar metals, such as a copper and iron wire, are joined together at both ends, the free electrons will pass haphazardly in both directions across the junction. Because of the different atomic structure of the metals, electrons pass more readily in one direction than in the other. This results in a displacement of charges, making one metal positive and leaving the other negative. By keeping one junction at a higher temperature than the other, a thermal electromotive force is obtained, and an electric current is produced.

A single junction of two different metals that are twisted, brazed or riveted together at one end, is called a thermocouple. Thermocouples are not used to produce electric current, since the effect is small. Their chief use is for measuring temperatures and currents in electrical appliances and furnaces.

What is electrochemistry?

In 1795, the Italian physicist Alessandro Volta made the first electrical cell by placing two dissimilar metal electrodes in a conducting chemical solution, called an electrolyte. An electromotive force is produced in such a cell by the separation of charge, brought about by the chemical reaction between the elec-

DRY CELL

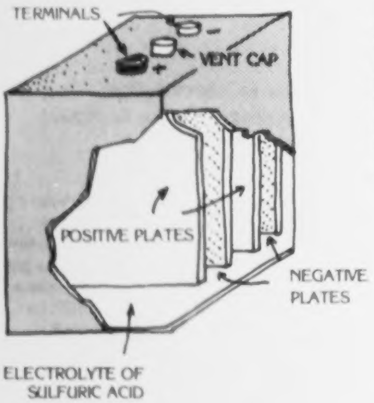


trodes and the electrolyte. This arrangement is known as a voltaic cell after its inventor. The electromotive force generated by a voltaic cell depends on the tendency of the electrodes' atoms to lose electrons and thus form positive ions.

The voltaic cell most widely used as a convenient source of "portable" electricity is the "dry cell," or common flashlight battery. A typical dry cell consists of a zinc metal housing, which acts as the negative electrode, and a carbon rod in the center, acting as the positive electrode. The electrolyte is a chemical paste consisting of ammonium chloride mixed with manganese dioxide. The manganese dioxide absorbs hydrogen produced from the chemical reaction. In operation, the metallic zinc delivers positive zinc ions to the electrolyte, causing a difference in charge between the zinc and carbon electrodes. If the zinc and carbon electrodes are connected in a circuit, electrons will flow from the zinc electrode to the carbon electrode, producing an electric current of about 1.5 volts. Since the electric current produced by a battery flows only in one direction, it is called direct current (DC).

Secondary cells, also called lead storage batteries, deliver current by chemical reaction like voltaic cells. However, the chemical reaction in a secondary cell is reversible, permitting it to be restored to its original condition. To restore or recharge a secondary cell, all you have to do is pass an electric current through it in a direction opposite to that of its normal use or discharge. The lead storage batteries in automobiles are secondary cells.

LEAD STORAGE BATTERY



What are magnetism and electricity?

Magnetism and electricity are not two separate phenomena. In fact, whenever an electric current flows, a magnetic field is created, and whenever a magnet moves, an electric current is produced. The properties of magnetism and electricity are both bound up in the nature of the physical structure and arrangement of atoms and their electrons. Materials that appear to be magnetic, without any outside source of electricity, depend on electron movement within their atomic structure to provide the electric current.

Electromagnetism is the effect by which electrical currents produce magnetic fields. The magnetic field around a straight wire is weak. Stronger magnetic fields are obtained by coiling wire into a spiraling loop, known as a solenoid. The effect of forming a solenoid is to increase the intensity of the magnetic field without having to increase the current. An iron-cored solenoid has a stronger magnetic field than that of an air-cored solenoid. This is because the electrons in the iron align themselves with the magnetic field produced by the current. Iron-cored solenoids are called electromagnets. Electromagnets energize the fields of motors and generators, and are part of telephones, loudspeakers, buzzers, electric bells, telegraphs, relays, electric meters and many other devices.

To produce an electric current from a magnet, the magnet must rotate inside a loop of wire or the wire loop must rotate between two magnets. The magnet creates an electromotive force, which causes the electrons in the wire to move, inducing an electric current. The rotation of the magnet or wire loop alternates between "pushing" and "pulling" the electrons, due to the magnet's polarity. The electric current produced thus alternates its direction of flow, and is therefore called alternating current (AC). Alternating current changes direction 60 times a second in the United States.

How do motors and generators work?

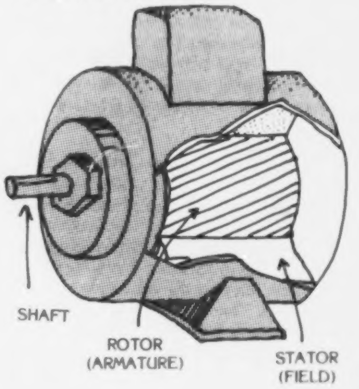
Motors and generators are basically the same in construction, although their functions are opposite. Motors are supplied with electrical energy to provide mechanical energy; generators are supplied with mechanical energy to produce electrical energy.

The two most essential elements of each of these machines are field and the armature. The field is a magnetic field which may be derived from permanent magnets or electromagnets.

The armature is a conductor arranged to pass through the field's magnetic lines of flux at right angles. The armature conductors may be wound onto a cylinder that rotates in the field, or they may be fixed to the inner walls of a cylinder, within which the field windings rotate. The armature is generally wound on a soft iron core to produce maximum flux for a given current. The soft iron is laminated (made up of thin slices) to prevent the electric current from circulating in the iron itself, and thus generating heat. The static part of the machine is called the stator and the revolving part the rotor. Both the field and the armature may be on either the stator or the rotor.

The armature must be supplied with electrical current if it is the rotor of a motor, and there must be a way of taking the electric current from it if it is a generator.

ELECTRIC MOTOR



What is a transformer?

One of the most essential electrical devices is the transformer. It is used in power stations and at substations — in the former to boost voltages for transmission over power lines and in the latter to reduce voltages to levels suitable for industrial or domestic use. Transformers contain two separate wire coils wrapped around an iron core. Electricity flows into the transformer through the first coil. As the electricity flows through the first coil, it produces a magnetic field in the iron core. The magnetic field then induces an electric current in the second coil which flows out of the transformer. Oil is circulated around the coils and iron core to insulate and cool the transformer. If the voltage is to be increased, the second coil contains more turns of the wire than the first coil. If the voltage is to be decreased, the second coil contains fewer turns of the wire than the first coil. Transformers are also used in many electrical appliances — such as radios, televisions and battery chargers — wherever voltage different from the supply is required.

How does the light bulb work?

The incandescent light bulb consists of a thin resistive tungsten filament, attached to a metal screw-type base. The filament is mounted inside a glass bulb, which is filled with an inert gas—either argon or nitrogen. The inert gas prevents the rapid burning of the filament. The resistance causes the filament to be heated to incandescence, producing light.

Fluorescent light bulbs contain filament electrodes at each end of the tube. The tube wall is coated with phosphor (a material that fluoresces under ultra-violet radiation) and is filled with mercury vapors. Electricity flows through the filament, causing the filament to emit electrons. The electrons cause the mercury vapor to break down and discharge ultra-violet radiation, which causes the phosphor to fluoresce, producing light.

Fluorescent lights are more efficient than incandescent lights. A 40-watt fluorescent light bulb will produce the same amount of lumens (light) as a 150-watt incandescent light bulb.

How does a circuit work?

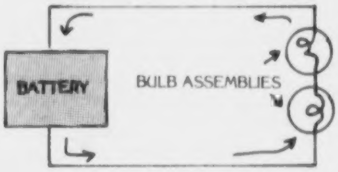
An electric circuit is the system by which an electric current is directed, controlled, switched on, or switched off. Circuits can contain from two or three to many hundred different components, according to the way in which the current is to be controlled.

The primary requirement of a circuit is that it form a complete path; electrons must be able to flow through the whole system so that as many electrons pass back into the source of the current as leave it.

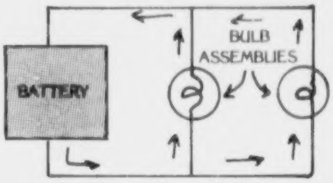
If the electricity is able to flow completely through the circuit, the circuit is said to be a "closed-circuit." If the electricity is unable to flow completely through the circuit, the circuit is said to be an "open-circuit."

There are two basic circuits in which electricity flows — series or parallel circuits. In a series circuit all of the electrical components are connected to each other in a "series," thus, the electric current has only one path to follow and flows through each component. In parallel circuits, the electrical components are connected individually to the main electrical circuit; thus, the electric current has more than one path to follow. Parallel circuits allow for individual control of each electrical component. Buildings, most appliances, motors, etc., are wired in parallel circuits.

SERIES CIRCUIT



PARALLEL CIRCUIT



How is electricity distributed in the home?

Electricity is brought to a house through a three-wire cable and connected via an electric meter, which indicates power consumption to the household circuit breaker or fuse box. The two "live wires" are then brought from the fuse box to power outlets (plug-ins), utility boxes (lighting), and wall switches. Each of the two live wires is at a voltage of 120 volts relative to ground and 240 volts relative to each other. The third wire, or neutral, is brought to a grounding bar in the circuit breaker box, or attached to a metal cold water pipe, as well as to all power outlets, utility boxes, and wall switches. Every appliance that is plugged into an outlet also has a ground connection. The appliance ground is connected to the metal or plastic case of the appliance.

If the two live wires should inadvertently come in contact with each other or the ground, a "short circuit" occurs which can result in a fire. In a properly wired house, such a short circuit causes a fuse to melt or a breaker to open, thus breaking or opening the circuit preventing electricity from flowing to that portion of the house or appliance and causing damage.

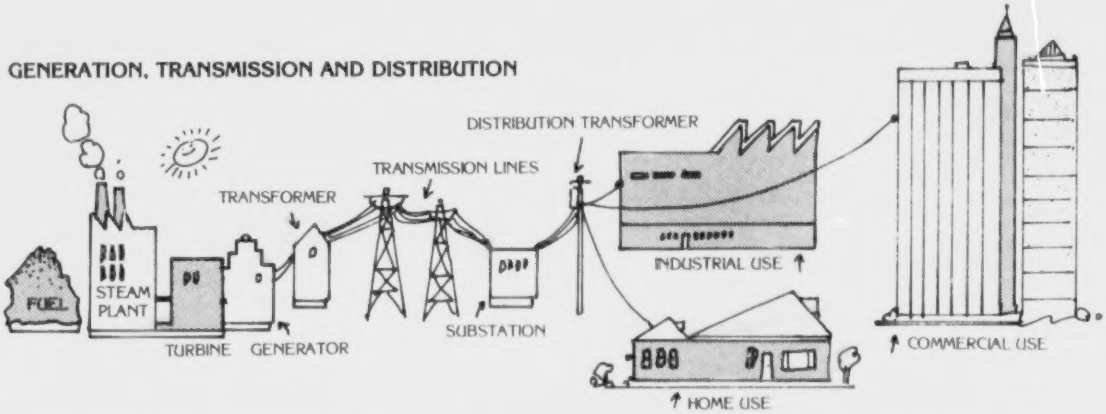
Fuses contain a metal alloy strip that melts when overloaded. Circuit breakers are essentially heat- or current-activated switches that open when overloaded.

At each power and lighting outlet no current flows until a lamp or appliance is plugged in and switched on. However, there is always a voltage at that point whether current flows or not. It is like a water tap; the pressure is always there although there is no flow until it is turned on.

How is electricity generated, transmitted and distributed?

Heat produced by the combustion of fossil fuels (coal, oil or natural gas) or the fission of uranium is used to convert water to steam. The steam is then piped to a turbine where it strikes the turbine blades, causing the turbine shaft to rotate. The rotating turbine shaft is connected to the generator's wire coil. As the turbine shaft rotates, it causes the generator's wire coil to spin. The spinning wire coil is surrounded by

GENERATION, TRANSMISSION AND DISTRIBUTION



magnets, which induce an electric current in the wire coil. The generator produces an electric current of about 22,000 volts. The electric current flows from the generator to the power plant transformer where the voltage is increased or stepped up.

The voltage is increased to reduce transmission loss. Transmission loss is due to the resistance of the transmission line to the flow of the electric current. The resistance produces heat. As the electric current increases, so does resistance and thus transmission loss. Since the same power can be obtained by transmitting electricity either at high current and low voltage or high voltage and low current, it is more efficient to transmit electricity at high voltage and low current, as less electricity is converted to heat through transmission line resistance. However, at high voltages the air surrounding the transmission line becomes partially ionized and some electricity is lost through atmospheric discharge. The distance the electricity needs to be transmitted determines how much the voltage is increased; the voltage can be stepped up as high as 765,000 volts. A 765,000-volt transmission line transports about as much electricity as five 345,000-volt transmission lines, due to transmission loss of the lower voltage system. From the power plant transformer, the electricity is transmitted throughout the electric utilities' service area through high power transmission lines. The utility's transmission lines are also connected with other electric utilities' transmission lines forming a power pool. The transmission lines transport the electricity to the electric utility's local substations. Substation transformers decrease or step down the voltage to between 5,000 and 35,000 volts (12,000 volts is the most common). Wooden power-pole distribution lines carry the electricity from the substation to consumers. However, before the electricity is used by the consumer, its voltage is stepped down by the power-pole transformer. The voltage is stepped down to either 120 or 240 volts.

What is energy conservation?

Electricity, while one of the most convenient forms of energy, is also one of the most inefficient. Steam turbine efficiencies have risen from 5 percent early in this century to about 35 percent today, but this still means that 65 percent of the coal or oil burned in power plants is lost as waste heat and pollution. The generating efficiency of an electrical network, including losses in transmission, is about 25 percent. A further small loss occurs when electricity is converted into heat, light, or mechanical energy of appliances, producing an overall efficiency of about 22 percent. However, electricity can do things that other energy sources cannot. It can drive a whole variety of household machines, power record players and television sets, and provide instant, clean and effective lighting.

Since much of our electricity must be produced through the use of the earth's supply of fossil fuels, conservation is important. Residential appliances consume roughly one-third of the electricity produced in the United States. Refrigerators alone utilize the electrical output of about 25 large power plants, nearly seven percent of the nation's consumption. Improving the energy efficiency of appliances is, therefore, an important step toward conserving fuel resources.

When buying home appliances it is important to check the energy efficiency rating and purchase the right size appliance. Oversized appliances consume more electricity and undersized appliances will have to work harder and thus, consume more electricity. Always compare the wattage of appliances (wattage will inform you how much electricity the appliance will consume). Also be sure to turn off lights and other electrical appliances when you are not using them.

Is electricity safe?

Electricity, when used properly, is a safe and convenient form of energy, but when used improperly, electricity can cause fires, shocks, injuries, and even death. The following safety tips will help you avoid electrical accidents.

- Be careful with electrical cords: don't place cords where people will trip over them or where they will receive excessive wear; keep cords away from heat and water; don't pull on cords to disconnect them, pull on the plug; and don't twist, kink or crush cords.
- Never use an appliance while standing in water or when wet.
- Don't touch metal plumbing or metal objects and appliances at the same time.
- Keep combustible materials away from lamps or heating devices.
- Disconnect appliances before cleaning.
- Keep ladders away from electric power lines.
- Turn off circuits when changing light bulbs.
- In case of an electrical fire, call the fire department; unplug appliance if safe; use fire extinguisher or baking soda, never use water.

BEST COPY AVAILABLE

- Never touch broken electric lines. Call police and the electric company immediately.
- In case of electric shock, do not touch victim until electricity is turned off. If victim is in contact with electric power lines, the only safe procedure is to call the power company. If victim is in contact with low voltage cord, use a dry rope or stick to remove victim. Call hospital and, if necessary, give artificial respiration or, for shock, cover victim and raise his/her feet.
- Never attempt to remove a kite from electric power lines, and be aware of the location of electric power lines when flying kites.
- When climbing trees, be sure that electric power lines don't touch the tree; if so don't climb the tree.

Notes:

Food: The Fuel That Keeps You Going

Introduction

Everyone knows that the real reason to eat isn't simply for pleasure. Eating is what provides our bodies with the energy to live. The attractive colors, aromas, flavors and textures of favorite foods aren't really important to the solid necessity of eating for survival. They do play a role, however, since they provide variety and make eating a lot more enjoyable.

Where does energy in food come from?

The food chain for humans begins with plants. Under ordinary growing conditions, plants require soil, water, air and sunlight. Of these elements, the energy source is sunlight, or solar energy, which is used by the plant leaves to combine chemicals from air and water.

Carbon dioxide from air and hydrogen from water are combined to form carbohydrates. These carbohydrates, stored in the plant's leaves, stems and roots, are the major energy source for the animals (including humans) who eat them.

Plants get their food from the soil which supplies chemicals for making proteins, vitamins and minerals.

When we, in turn, eat plants, our bodies use these proteins, vitamins and minerals as building materials for bones, muscles and all the rest of our physical parts.

It's the carbohydrates, though, that we use for energy. Our bodies break down the carbohydrates into three fuels. **Glucose** is the fuel we use for a constant level of energy. **Glycogen** provides an extra-rich fuel for sudden emergencies. And **fat** is a long-term storage fuel.

All three fuels are necessary to provide the heat that keeps our bodies operating at a constant temperature of 98.6° F (37° C). These fuels also provide the energy for your heartbeat, breathing, walking, talking and other physiological functions.

When we eat beef, fish, poultry and other meats, we are really eating plants that have been converted to another form. The energy is still there.

How is energy used to make food and deliver it to us?

The days are long gone when most people grew their own food and survived independently. Today, much of what we eat comes from other people and places and is the result of a complex series of events.

A good example of a staple crop is corn.

Corn requires many chemicals from the soil, so farmers must keep fertilizing the soil to replace important chemicals. Usually, fertilizers made from natural gas are used.

Farm machinery, of course, burns gasoline or diesel fuel to do the plowing and planting. If rainfall is poor, farmers may need to irrigate, which requires electricity to run the irrigation pumps. Pesticides made from petroleum keep the corn healthy.

Then, fuel-burning machinery picks the corn which is transported by truck or rail to where it is sold. Since this may be thousands of miles away, the fuel (and energy used) is often substantial.

Once the corn gets to you, other forms of energy may be necessary to husk it, clean it and cook it to your tastes.

Meanwhile, energy is being used to produce and ship many other types of foods which will eventually end up on your table.

And the entire process has only one purpose: to give you energy to survive.

(Adapted from **Energy Readings**, part of the New York Energy Education Project, with permission of the New York Power Pool.)

Notes:

Energy Lessons

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29. Energy Saving Survey	105	Conservation	X		X		
30. How Much TV Do You Watch?	107	Conservation	X	X	X		
31. Keep It Cool!	110	Conservation	X				X

Questioning 'Yes or No?'

Activity
1

	Sources	Grades	Time
Language Arts, Science	☼	**4-6**	**30 min.**

Concept

Energy sources can be classified in many different ways.

Activity Goal

The students will use this inquiry process as one technique for obtaining data about energy sources.

What You'll Need

- Markers
- 3" x 5" card for each student
- Tape

What To Do

1. On 3" x 5" cards, write the following energy sources (One on each card):

1. Coal
2. Oil
3. Sun (Solar)
4. Gasoline
5. Wood
6. Nuclear
7. Ocean Current
8. Geothermal
9. Hydro
10. Natural Gas
11. Garbage
12. Wind
13. Plants
14. Oil Shale
15. Tar Sands
16. Ocean Tides

Duplicate the source of energy cards in order to have enough for the class.

You may wish to preview the list of sources and discuss with students before beginning the activity. You may also wish to delete or add words such as fission or fusion.

2. Explain the rules of the activity:

A. You may ask only three questions.

B. Questions can be answered with only "yes" or "no."

C. Tape the cards on the backs of everyone in the room and allow them to ask their questions. If anyone identified their energy source, they are to continue to answer questions for the others.

D. As students identify their energy sources, take their cards off their backs and put them on their chests.

3. After 20 minutes, stop the activity and have the students place their cards on their chests. Then have them group themselves according to similar energy source or other characteristics. Have each group explain how they have grouped themselves.

4. Finalize activity by going over each energy source with students. Determine those energy sources that are not located in your area.

Ga
Ocean Tides

Career Awareness Idea

As a class, list the energy sources used in your local area and name two occupations that work directly with that source (e.g., coal = coal miner).

Evaluation Idea

Select the best answer:

1. Coal is:
   (A) a fossil fuel
   (B) a renewable source of energy
   (C) a product of oil
   (D) a liquid

2. A substance that usually occurs naturally as a black liquid is:
   (A) coal
   (B) oil
   (C) gasoline
   (D) geothermal

3. The sun:
   (A) is a fossil fuel
   (B) occurs underground
   (C) is an energy source
   (D) can be converted into oil

4. Gasoline is:
   (A) a solid
   (B) a product of geothermal
   (C) naturally occurring
   (D) a product of petroleum refining

5. Geothermal energy is:
   (A) found everywhere
   (B) a fossil fuel
   (C) formed from oil
   (D) from the earth

6. A colorless, odorless gas is:
   (A) gasoline
   (B) natural gas
   (C) garbage
   (D) nuclear

7. A radioactive energy source is:
   (A) garbage
   (B) tar sand
   (C) oil
   (D) nuclear

8. A solid, renewable energy source that burns is:
   (A) tar sands
   (B) coal
   (C) wood
   (D) oil

9. A nonrenewable energy source is:
   (A) wind
   (B) ocean currents
   (C) plants
   (D) oil shale

10. All of the following are fossil fuels except:
    (A) oil
    (B) oil shale
    (C) tar sands
    (D) geothermal

Answers
1-A, 2-B, 3-C, 4-D, 5-D,

6-B, 7-D, 8-C, 9-D, 10-D

Energy Source Password

Activity
2

	Sources	Grades	Time
Science, Art, Language Arts	☼	**4-6**	**45 min.**

Concept

Energy sources can be classified in many different ways.

Activity Goal

The students will identify and use vocabulary words related to the topic of energy sources in a game situation.

What You'll Need

- Index cards for password clues

What To Do

1. The success of this activity depends upon adequate student preparation. Class time should be spent learning to spell and define the following energy source words:

geothermal
coal
nuclear energy
oil
fission
crude
fossil fuels
solar
wind
oil shale
gasoline
battery
steam
methane
ocean waves
tides
hydroelectric
uranium
water
waste
petroleum
biomass
natural gas
wood
fusion

2. Divide the class into two groups of approximately equal ability. Choose one student from each team to give clues and have them sit at the front of the room. This game is played like the TV game of "Password," except that each clue giver will be giving clues to his/her team rather than to one partner.

3. You may want to use the list of suggested words included or add your own choices.

4. How the game is played:

A. Each of the clue givers is shown a password.

B. The clue givers then give clues alternately to their teams as to the identity of the password. Some teachers allow only one-word clues to be given you may prefer to allow more clues within a certain time period, such as 15 seconds. (Have one student be the timekeeper.)

C. After giving a clue, the clue giver chooses someone on his/her team to guess what the password is. If that team member guesses the correct word, his/her team scores, and a new round begins using a new password. Alternately, team members guess the word by order of seating rather than being chosen by the clue giver to guess the word.

D. If the team member guesses incorrectly, the turn goes to the other clue giver, who gives a new clue to a member from his/her team.

E. After the word has been guessed correctly by one team or the other, the new word goes first to the clue giver who did not start the previous round.

F. Scoring is as follows:

--10 pts. for the team guessing the word correctly on the first clue.
--9 pts. if the correct word is guessed on the second clue.
--8 pts if the team guesses the password after hearing the third clue, etc.

G. New clue givers should be chosen from each team after every three or four rounds have been played.

Optional Activity

Have students write a short story where the characters in the story are based on several of the energy source words. Have students create an illustration of their short story.

Evaluation Idea

Have students spell and define/describe the following words:

natural gas
geothermal
hydroelectric
coal
fossil fuel
uranium
petroleum
nuclear energy
solar energy
wind energy
oil shale
steam power
methane
wave energy
biomass

WOOD
STEAM
WIND
OIL
WATER
WASTE

Energy Source Lingo

Activity
3

Science, Language Arts	Sources	Grades	Time
	☼	4-6	30 min.

Concept

Energy sources can be classified in many different ways.

Activity Goal

The students will become familiar with the various energy sources as a result of playing a word game.

What You'll Need

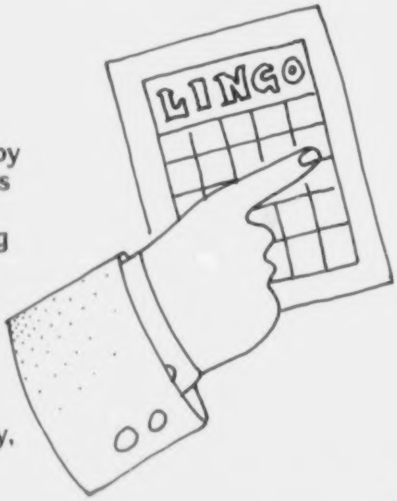
- Word definition strips
- "Lingo grids"
- Corn, beads, or any object to mark words

What To Do

1. Introduce the activity by indicating that the class is going to play a word game. Place the following Lingo vocabulary on the chalkboard or distribute the following list as a handout:

natural gas, crude oil, propane, methane, energy, BTU, hydrocarbon, coal nuclear energy, solar energy, hydroelectric, electricity, gasoline, uranium, chemical energy, heat energy, wood, oil shale, refuse, wind, geothermal, fossil fuels, fuel, renewable energy, food, charcoal, synthetic fuel, lignite, tidal power, primary energy, fission, fusion

2. Distribute the lingo cards (Student Handout) and instruct students to write one of the vocabulary words in each of the squares, leaving the middle space as a "free" space. Students may mix the words any way they wish. Explain that Lingo is played like Bingo.



3. Distribute corn, beads, or other space markers.

4. Have the caller draw definition strips from a bag or box. Read the definition only. If the students can match the definition with a word on their list, then they should place a marker over that word. Continue until a student has a "Lingo," a complete line up, across or diagonally.

5. The student who has called "Lingo" must then correctly define all the words in his/her lingo. If the student cannot correctly define the words the game continues.

6. After several plays, go over each word and definition with students. You may wish to repeat the game in one week to check retention.

Evaluation Idea

Have students define the energy words used in this activity.

WORD DEFINITION STRIPS

Natural gas:
A combustible gas found in the earth used to heat homes, water, and cook food.

Crude oil:
Formed from animal and plant material at the bottom of ancient seas. Usually a black liquid.

Propane:
A combustible gas found in natural gas. It contains 3 carbons and 8 hydrogen atoms (C_3H_8).

Methane:
The most common combustible gas found in natural gas. It contains 1 carbon and 4 hydrogen atoms (CH_4).

Energy:
The ability to do work, derived from the conversion of an energy source.

BTU:
A measure of heat energy (British thermal unit).

Hydrocarbon:
A molecule made of hydrogen and carbon atoms: coal, oil, natural gas.

Hydroelectricity:
Electrical energy produced by a water-powered turbine generator located inside a dam.

Coal:
A black combustible solid formed from plants. Often used to generate electricity.

Nuclear energy:
Energy produced by changes in the nucleus of atoms.

Solar energy:
Radiation energy from the sun. The primary source of all energy.

Gasoline:
Produced from refined crude oil.

Uranium:
The fuel used in a nuclear reactor to generate electricity.

Chemical energy:
A form of energy contained in coal, natural gas, and oil.

Heat energy:
A form of energy produced from the combustion (burning) of coal, oil, or natural gas, or the fission of uranium.

Wood:
Formed from the conversion of the sun's energy through photosynthesis.

Refuse:
Useless, unwanted or discarded materials (garbage). Can be used to generate electricity or produce natural gas.

Wind:
A form of kinetic (moving) energy produced in part by the sun's heating of the earth.

Geothermal:
Heat energy from within the earth.

Fossil fuels:
Formed from ancient plants and animals: coal, oil, natural gas.

Fuel:
Something which burns to produce heat energy

Food:
Stored chemical energy produced by the conversion of solar energy through photosynthesis. A source of energy for animals.

Renewable energy:
A nondepletable source of energy such as the sun.

Fusion:
The combining of atoms to release energy.

Oil shale:
A sedimentary rock containing kerogen. The kerogen when heated yields crude oil.

Charcoal:
A carbon containing material produced by the heating of wood. Often used as a fuel.

Synthetic fuel:
Gaseous or liquid hydrocarbon fuel produced from a solid hydrocarbon fuel, such as coal.

Lights:
A brownish, peat-like coal.

Tidal power:
Power obtained from falling and rising ocean tides.

Primary energy:
Energy in its naturally occurring form: coal, oil, natural gas.

Fission:
A splitting of atoms to release energy.

L	**I**	**N**	**G**	**O**
		Free		

Electricity Serves Us

Activity
4

	Sources	Grades	Time
Science, Art, Language Arts	☼	**4-6**	**60 min.**

Concept

Each source of energy can be used in many ways.

Activity Goal

The students will identify sources of energy that produce electricity and ways electricity serves our community.

What You'll Need

- Copy of "Electricity Serves Our Community" poster handout for each student
- Crayons or markers

What To Do

1. Give each student a black and white copy of the "Electricity Serves Our Community" poster handout.

2. Discuss with the students the sources of energy illustrated on the poster that produce electricity. (For additional background information on the energy sources refer to the "Energy Basics" at the front of this book.)

3. Using the poster, show the students where energy is converted into electricity, and how it travels to their home.

4. Ask the students to help make a list on the chalkboard of ways electricity is used in their homes and community.

5. As a review, have the students do the poster activities listed on the poster.

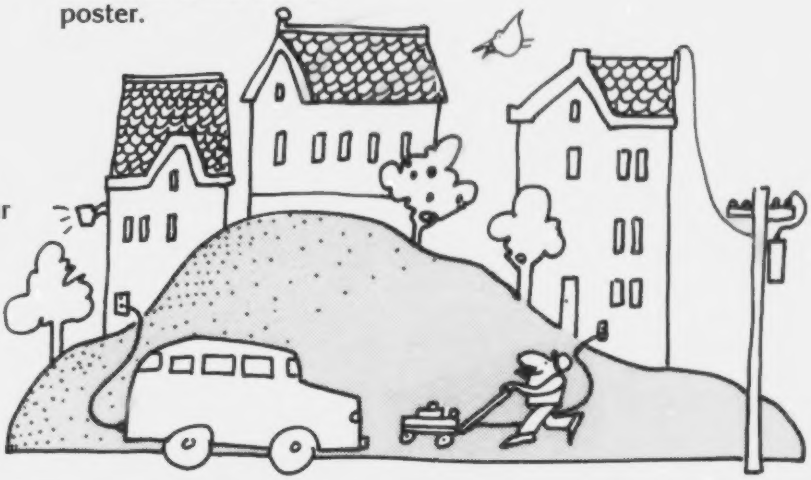
Career Awareness Idea

Invite a representative from your local utility company to come to the class and discuss how electricity gets to their homes.

Evaluation Ideas

1. Have the students name the sources of energy that can be used to produce electricity.

2. Have the students list 10 ways electricity is used in their community.

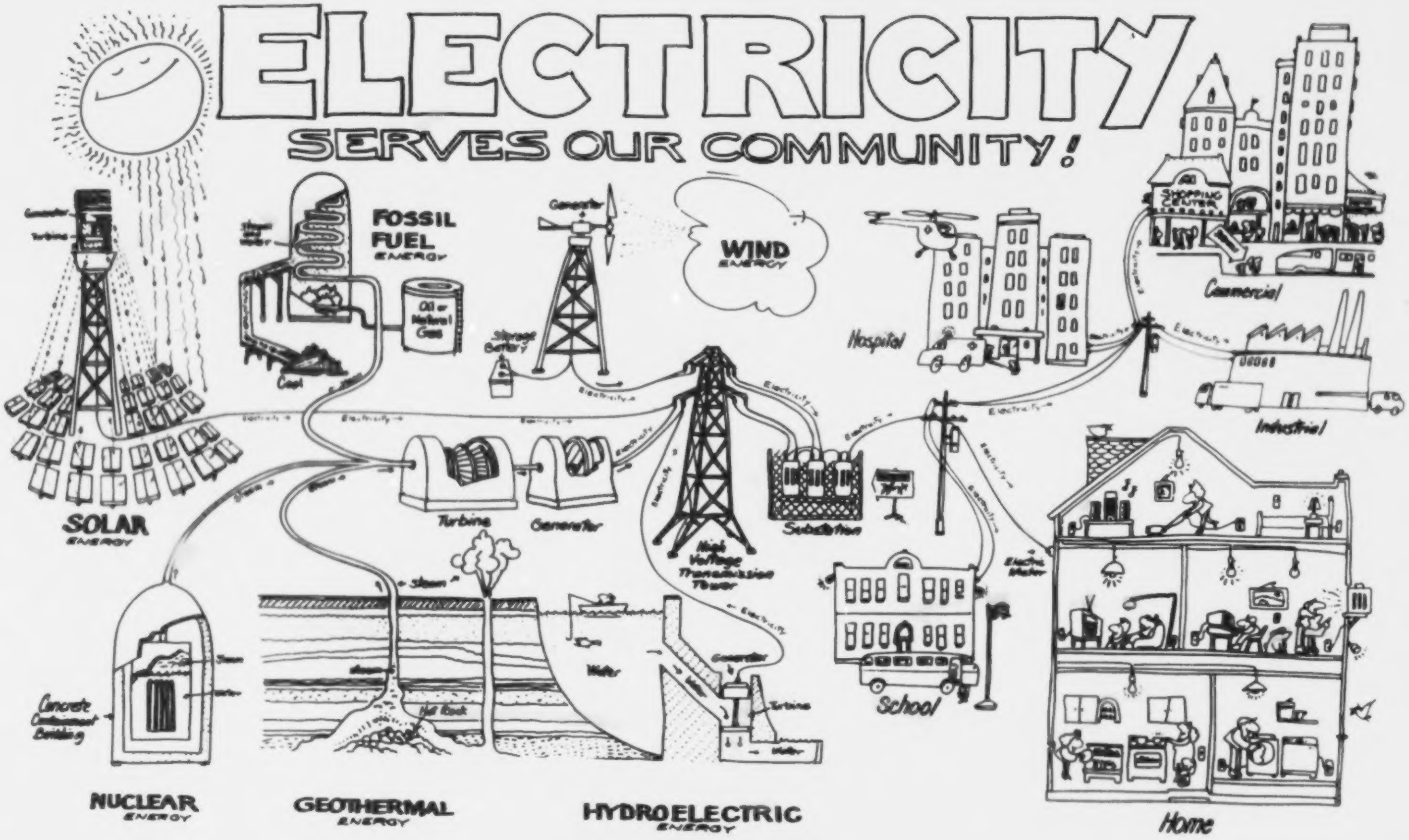


This art work is available as a full-color 23" x 35" poster from the National Energy Foundation, 5160 Wiley Post Way, Suite 200, Salt Lake City, Utah, 84116. Phone number: (801) 539-1406.

POSTER ACTIVITIES

Try these great poster activities:

1. Color the sources of energy shown on the poster that produce electrical energy.
2. Color the area where energy is converted into electricity
3. Color the areas in the home where electricity is being used.
4. Put an X by the areas that show electricity being used in the community.
5. Make a list of 10 ways electricity is used in school.
6. Write a poem about electricity based on the poster pictures.


ELECTRICITY
SERVES OUR COMMUNITY!
Generator
Turbine
FOSSIL FUEL ENERGY
Oil or Natural Gas
Coal
Generator
Storage Battery
WIND ENERGY
Hospital
Shopping Center
Commercial
Industrial
Electricity
Turbine
Generator
High Voltage Transmission Tower
Substation
SOLAR ENERGY
Steam
Hot Rock
Water
Generator
Turbine
Concrete Containment Building
Electric Meter
School
Home
NUCLEAR ENERGY
GEOTHERMAL ENERGY
HYDROELECTRIC ENERGY

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‘Mix and Match’

Activity 5

	Uses	Grades	Time
Language Arts, Science	⚙	**4-6**	**30 min.**

Concept

Each form of energy can be used in many ways.

Activity Goal

The students will gain information about energy use by matching subject phrases with predicate phrases.

What You'll Need

- 3" x 5" card for each student
- Markers

What To Do

1. Prepare 2 sets of cards. One set should be a different color than the other. On one set of cards, place the subject phrases of a complete sentence on each card. Place the predicate phrases on the cards of the other color. Complete all the cards using about 16 sentences. Sentences can be about energy sources, uses, occupations, etc.
See sample cards below.

2. Pass cards to the students.

3. Have the students move to each other, comparing cards, until all cards are matched. Students will then read their matches and identify the subject phrase and predicate phrase.

4. Have the students write a new predicate phrase for one of the subject phrases.

SAMPLE CARDS

1. A plant - uses the sun's energy.
2. Solar energy - is a renewable energy.
3. Gasoline - is refined from petroleum.
4. A scientist - discovers new energy sources.
5. A dam worker - uses water to produce energy.
6. The sun - is the primary source of energy.
7. A house - uses a furnace.
8. Nuclear power - is a source of energy used to produce electricity.
9. A car - uses oil to help it run.
10. Geothermal energy - is found under the ground.
11. A river - can be polluted.
12. A mine worker - works underground.
13. Energy - is converted.
14. Natural gas - is a fossil fuel, mostly methane.
15. Electricity - is made by a generator.
16. Coal - is formed from ancient plants.

Note: Often correct matches can be made in more than one way.

Evaluation Idea

Match the Following:

____ 1. Source of Energy
____ 2. Underground
____ 3. Furnace
____ 4. Generator
____ 5. Renewable
____ 6. Conserve
____ 7. Polluted
____ 8. Fossil Fuel
____ 9. Electricity
____ 10. Geothermal
____ 11. Gasoline
____ 12. Sun

A. To use efficiently
B. Natural gas
C. Energy that can be used to do work
D. Converts all energy sources to heat
E. Deep mines
F. Can make electricity
G. Can be formed again in a short time
H. Source of solar power
I. Contains unwanted substances
J. Produced by a generator
K. A form of energy used by many people in cars
L. Heat from the earth

Answers

1-C, 2-E, 3-D, 4-F, 5-G, 6-A, 7-I, 8-B, 9-J, 10-L, 11-K, 12-H

Energy Trip Ticket Game

Activity
6

	Uses	Grades	Time
Science, Art, Social Studies	⚙	**4-6**	**5x30 min.**

Concept

Every energy use decision affects standards of living and quality of life.

Activity Goal

The students will realize that energy conservation affects our standard of living.

What You'll Need

- Magazines
- Glue
- Butcher paper
- Energy Trip Tickets (included with this lesson)

What To Do

1. Using magazine pictures, have students make collages depicting the use of energy--things moving or being moved--in one of the following areas:

A. Things we use at home.

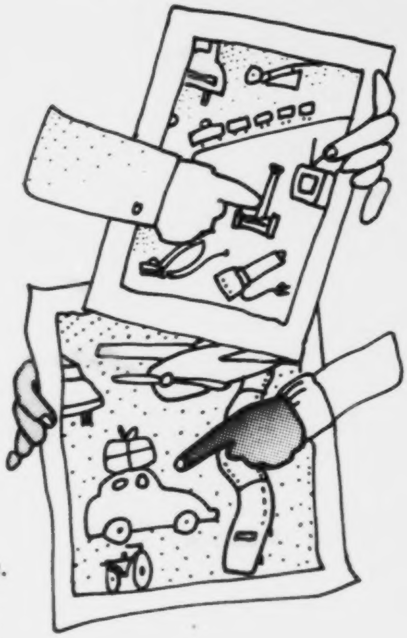
B. Things we use and do for fun.

C. Things we use for transportation.

D. Things we do for work (jobs).

You may want students to work in small groups, and then share collages with the class.

2. Class discussion: Compare the use of energy shown in each collage. How are they alike? How are they different? Which items on our collages make our lives easier and more comfortable? How?



3. To bring home the idea that it takes a lot of energy for people to have and do things, play the "Energy Trip Ticket Game."

A. To introduce the game to the students, list several places the students go in school.

Examples:
Lunch
Recess/P.E.
Music
Library
Pencil sharpener
Drinking fountain
Rest room

Tell them each trip they take now costs one energy ticket.

B. Give each student 15 tickets. The student's name should be on each of his or her tickets. Alternatively, the students could have deposit places marked with their names.

C. Keep a record of how many tickets the students have left each day. Which students are using more energy? Less energy? Making an effort to conserve? How are they conserving?

Discuss energy-saving ideas for trips around the classroom, e.g., at recess I can get a drink, sharpen my pencil, and go to the rest room for one ticket. Otherwise, it would cost me four tickets to make trips one at a time. This stresses the idea that in one trip, several things can be accomplished.

D. On the third day, discuss the prospect of running out of energy tickets. There are not enough tickets left for the rest of the week. What can we do to save? What will it cost? What affect will it have on our classroom standard of living?

E. On the fifth day, discuss the impacts the "energy shortage" had on the use of energy--the number of trips students made.

4. Using the collages, ask students which activities would be affected most if a real energy shortage occurred. How would that influence our lives, and our use of energy?

Evaluation Idea

Create a classroom list of ways consumers can conserve electricity, heat, gasoline, natural gas, coal, and other forms of energy.

ENERGY TRIP TICKET Name	**ENERGY TRIP TICKET** Name	**ENERGY TRIP TICKET** Name
ENERGY TRIP TICKET Name	**ENERGY TRIP TICKET** Name	**ENERGY TRIP TICKET** Name
ENERGY TRIP TICKET Name	**ENERGY TRIP TICKET** Name	**ENERGY TRIP TICKET** Name
ENERGY TRIP TICKET Name	**ENERGY TRIP TICKET** Name	**ENERGY TRIP TICKET** Name
ENERGY TRIP TICKET Name	**ENERGY TRIP TICKET** Name	**ENERGY TRIP TICKET** Name

Appliance Time Savers?

Activity
7

	Uses	Grades	Time
Science, Art, Language Arts, Mathematics	%	**4-6**	**60 min.**

Concept

Every energy use decision affects standards of living and quality of life.

Activity Goal

The students will recognize how people use energy at home to do work that once was done by hand.

What You'll Need

- Electric drill, hand drill
- Electric mixer, egg beater, bowls, flour, water
- Electric can opener, hand can opener
- Electric knife, hand knife
- Bar of soap
- Cutting block
- Block of wood
- Empty cans
- Collage material (magazines, scissors, glue)

What To Do

1. To get the students thinking about the amount of human energy spent and the amount of time it takes to do things, ask them if they would rather walk, ride a bike or ride in a car five miles to a friend's birthday party.

A. Ask them why they chose what they did.

B. Which would take the most time? The least?

C. Which would take the most human effort? The least?

D. Which would be the best exercise? Why?

2. After the discussion, demonstrate an electric knife, electric can opener, electric mixer, and electric drill to illustrate how people use energy to save time and effort. Have students record the amount of time that passes as you:

A. Cut a bar of soap with the electric knife and a hand knife.

B. Drill a hole in a block of wood with an electric drill and a hand drill.

C. Mix flour and water with an electric mixer and a hand mixer.

D. Open the bottom of empty cans with an electric can opener and a hand can opener.

3. Construct a bar graph similar to the one shown on the following page to illustrate the results of Step 2. Explain that we often use energy to make work easier and to save time.

4. Point out both the advantages and disadvantages of using convenient devices. Be sure to relate this to the standard and quality of life.

5. Make a collage showing the home appliances people use to reduce their work. Have students cut pictures from old magazines and catalogs.

Evaluation Ideas

1. Have students list at least four home appliances that are used to make work easier or to save time.

2. Have students write about how life would be different without electricity.

Do Electrical Appliances Save Time?

	Soap		Wood		Flour & Water		Cans	
Time (Seconds)								
150								
140								
130								
120								
110								
100								
90								
80								
70								
60								
50								
40								
30								
20								
10								
Appliance Or Device Used	Electric Knife	Hand Knife	Electric Drill	Hand Drill	Electric Mixer	Hand Mixer	Electric Can Opener	Hand Can Opener

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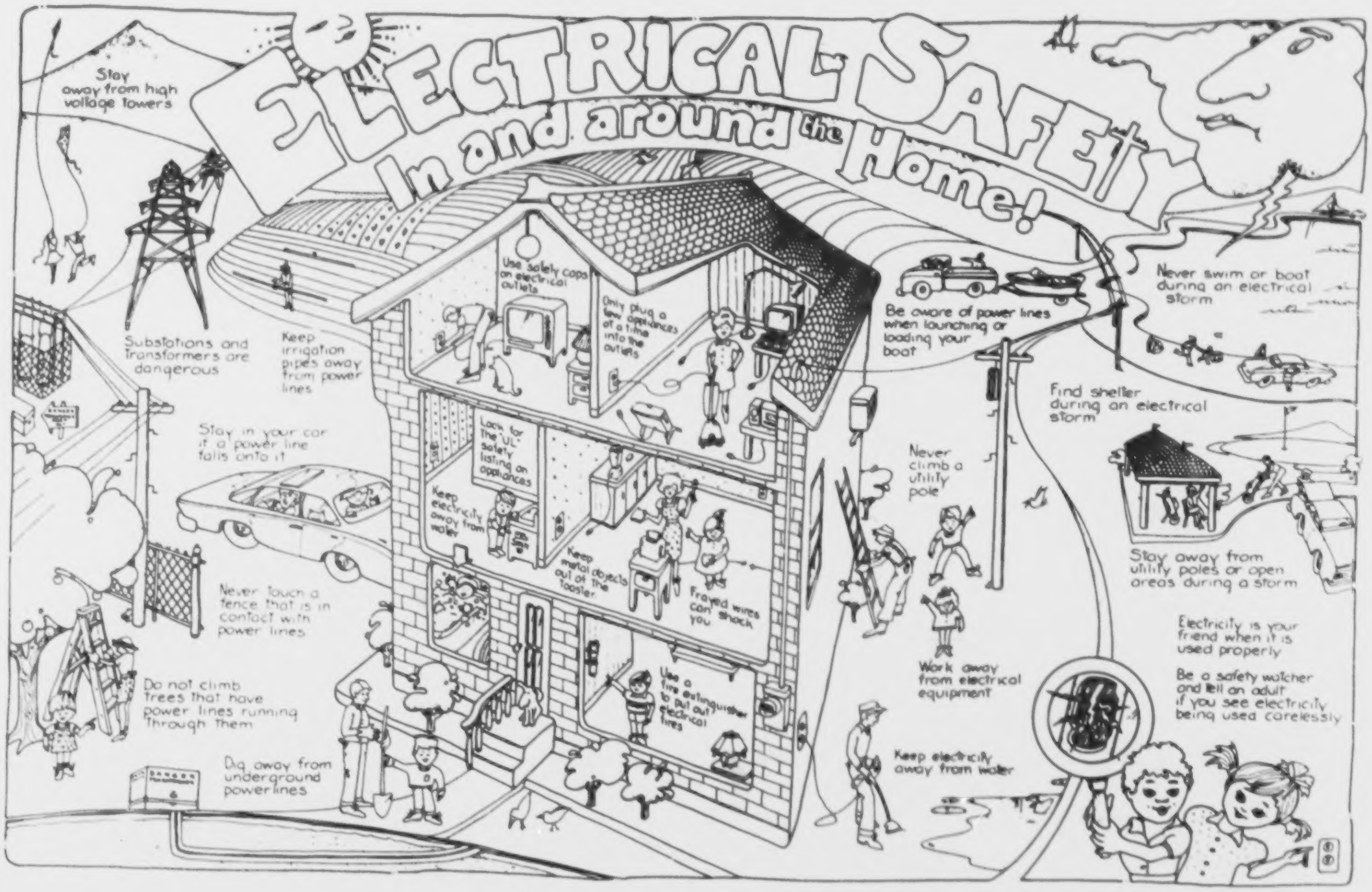
ELECTRICAL SAFETY
In and around the Home!
Stay away from high voltage towers
Substations and Transformers are dangerous
Keep irrigation pipes away from power lines
Stay in your car if a power line falls onto it
Never touch a fence that is in contact with power lines
Do not climb trees that have power lines running through them
Dig away from underground powerlines
Use safety caps on electrical outlets
Only plug a few appliances at a time into the outlets
Look for the "UL" safety listing on appliances
Keep electricity away from water
Keep metal objects out of the toaster.
Frayed wires can shock you
Use a fire extinguisher to put out electrical fires
Be aware of power lines when launching or loading your boat
Never swim or boat during an electrical storm
Find shelter during an electrical storm
Never climb a utility pole
Work away from electrical equipment
Keep electricity away from water
Stay away from utility poles or open areas during a storm
Electricity is your friend when it is used properly
Be a safety watcher and tell an adult if you see electricity being used carelessly

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Electrical Safety At Home

Activity
8

	Uses	Grades	Time
Science, Art, Language Arts	⚙	**4-6**	**2x45 min.**

Concept

There are health and safety factors associated with the development and use of energy resources.

Activity Goal

The students will learn basic rules for using electricity safely.

What You'll Need

- Copy of "Electrical Safety In and Around the Home" poster handout for each student
- Crayons or markers

What To Do

1. Give each student a copy of the black and white "Electrical Safety In and Around the Home" poster handout. Divide the class into several groups. Allow each group to examine the poster for a set period of time (e.g., 1 minute). Then write down all the possible electrical hazards they saw on the poster. The groups with the most listed wins!

2. As a class, discuss each illustration on the poster, emphasizing why it is important to be careful when using electricity. Have the students circle the potential hazards on their copy as you talk about each one.

3. Ask the students if they can think of other situations which could be potential safety hazards. List their ideas on the chalkboard.

4. Have the students color their poster, and if possible, display them.

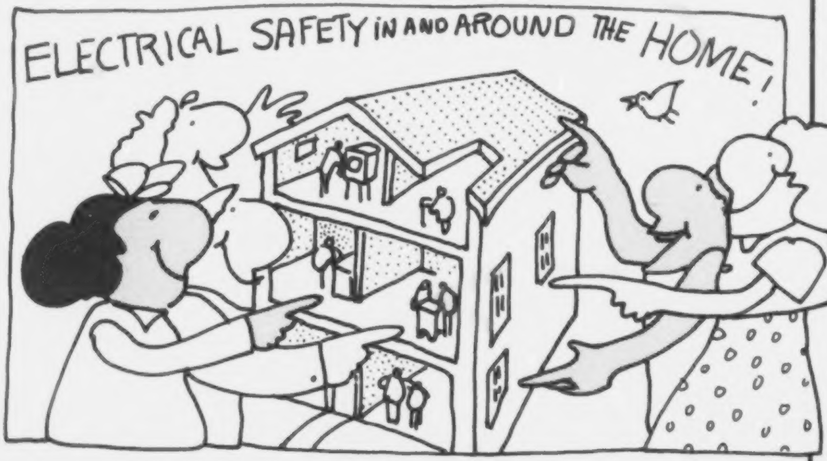
5. Have the students write an electrical safety public service announcement. To make this activity more exciting, the class can video tape their ads and play them for another class.

Career Awareness Idea

Invite a representative from the local electric utility or fire department to visit the class and discuss electrical safety.

Evaluation Idea

Ask the students to identify 10 possible safety hazards they might find in and around the home.


ELECTRICAL SAFETY IN AND AROUND THE HOME!

Discover Electrical Safety

Activity
9

	Uses	Grades	Time
Science, Language Arts	⚙	**4-6**	**45 min.**

Concept

There are health and safety factors associated with the development and use of energy resources.

Activity Goal

The students will become aware of electrical safety practices in their immediate surroundings.

What You'll Need

- 3" x 5" cards

What To Do

1. Discuss with the students the value of electricity and the need to use it safely.

2. Divide the class into teams of 5 students each.

3. Give each team 5 index cards.

4. Instruct the teams to seek and discover ways that electricity is being used safely in the classroom. Have them write each discovery on a separate index card. Allow 5 minutes for this activity.

Examples:

Keep electrical cords away from water and areas of excessive traffic; make certain that outlets are not overloaded and electrical cords are in good condition without cracks or fraying.

5. Allow the students time to discuss their discoveries with the class.
Talk about other safety principles that should be practiced in the classroom and at home.

Evaluation Ideas

1. Extend the activity to the rest of the school building.

2. Make posters about electrical safety.

Electrical Safety Watchers

Activity
10

	Uses	Grades	Time
Science, Language Arts	⚙	**4-6**	**2x45 min.**

Concept

There are health and safety factors associated with the development and use of energy resources.

Activity Goal

The students will identify ways electrical safety principles can be used in their homes.

What You'll Need

- "Electrical Safety In and Around the Home" poster handouts for each student
- Safety Watcher checklist for each student
- Electric Watcher Badge for each student
- Worn or broken electrical appliances
- Electrical Safety Watcher Certificate for each student

What To Do

1. Use old electrical appliances to show students what frayed cords or broken insulating materials look like. Some of the appliances may have broken plugs, or plugs that have been repaired. Place these appliances around the room to demonstrate how improper location of appliances can be a hazard.

2. Have the students study their copy of the "Electrical safety In and Around the Home" handouts. Emphasize hazards in the home.

3. Give each student a Safety Watcher checklist. Discuss how to complete the survey. Emphasize that students are not to correct any safety hazard. If they find a problem, they should notify an adult.

4. Assign students to fill out the checklist and bring it back to school the following day. (Don't evaluate students on the number of hazards they have found.) Reward students on the thoroughness or creativity they exhibit when doing their survey.

5. After the checklists have been completed, make a list on the chalkboard of the types of safety hazards the students found. Determine which were the most common.

6. Give each student an Electrical Watcher badge and/or Electrical Safety Watcher certificate for participating in the activity.

Evaluation Idea

Have each student write a report on what they would suggest their families do to improve electrical safety in and around the home.

SAFETY WATCHER CHECKLIST

	Safe	Needs Work	Dangerous	
LIVING ROOM	☐	☐	☐	Electrical Appliances (TV, Stereo, Video Games, etc.)
	☐	☐	☐	Lamps
	☐	☐	☐	Other ______________________
KITCHEN	☐	☐	☐	Electrical Appliances (Toaster, Microwave, Mixer, etc.)
	☐	☐	☐	Stove/Oven
	☐	☐	☐	Garbage Disposal
	☐	☐	☐	Dishwasher
	☐	☐	☐	Refrigerator
	☐	☐	☐	Other ______________________
LAUNDRY ROOM	☐	☐	☐	Washer/Dryer
	☐	☐	☐	Iron
	☐	☐	☐	Other ______________________
FAMILY ROOM	☐	☐	☐	Electrical Appliances (TV, Stereo, Video Games, etc.)
	☐	☐	☐	Lamps
	☐	☐	☐	Aquarium Lights
	☐	☐	☐	Other ______________________
BATHROOM	☐	☐	☐	Electrical Appliances (Curling Iron, Radio, Razor, etc.)
	☐	☐	☐	Other ______________________
BEDROOMS	☐	☐	☐	Electrical Appliances (Clock Radios, Computers, TV, etc.)
	☐	☐	☐	Night Lights
	☐	☐	☐	Other ______________________
BASEMENT OR UPSTAIRS	☐	☐	☐	Extension Cords
	☐	☐	☐	Electrical Appliances (Electric Power Tools)
	☐	☐	☐	House Wiring
	☐	☐	☐	Other ______________________
OUTDOOR ELECTRICAL EQUIPMENT	☐	☐	☐	Porch or Yard Lights
	☐	☐	☐	Electrical Yard Power Tools
	☐	☐	☐	Ornamental Devices (Christmas Lights, Water Pumps, etc.)
	☐	☐	☐	Other ______________________
GARAGE BARN/SHED	☐	☐	☐	Electric Power Tools
	☐	☐	☐	Electrical Space Heaters
	☐	☐	☐	Electric Cords
	☐	☐	☐	Other ______________________

Electrical Safety Watcher Certificate

This certificate is presented to

____

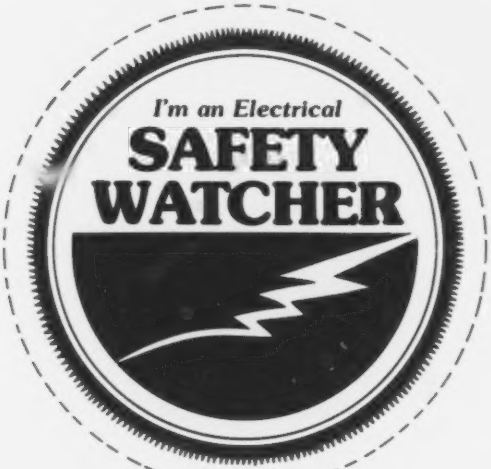
Student Name

For successfully participating in an Electrical Safety Watcher Program!

SEAL
OF EXCELLENCE
for Electrical Safety

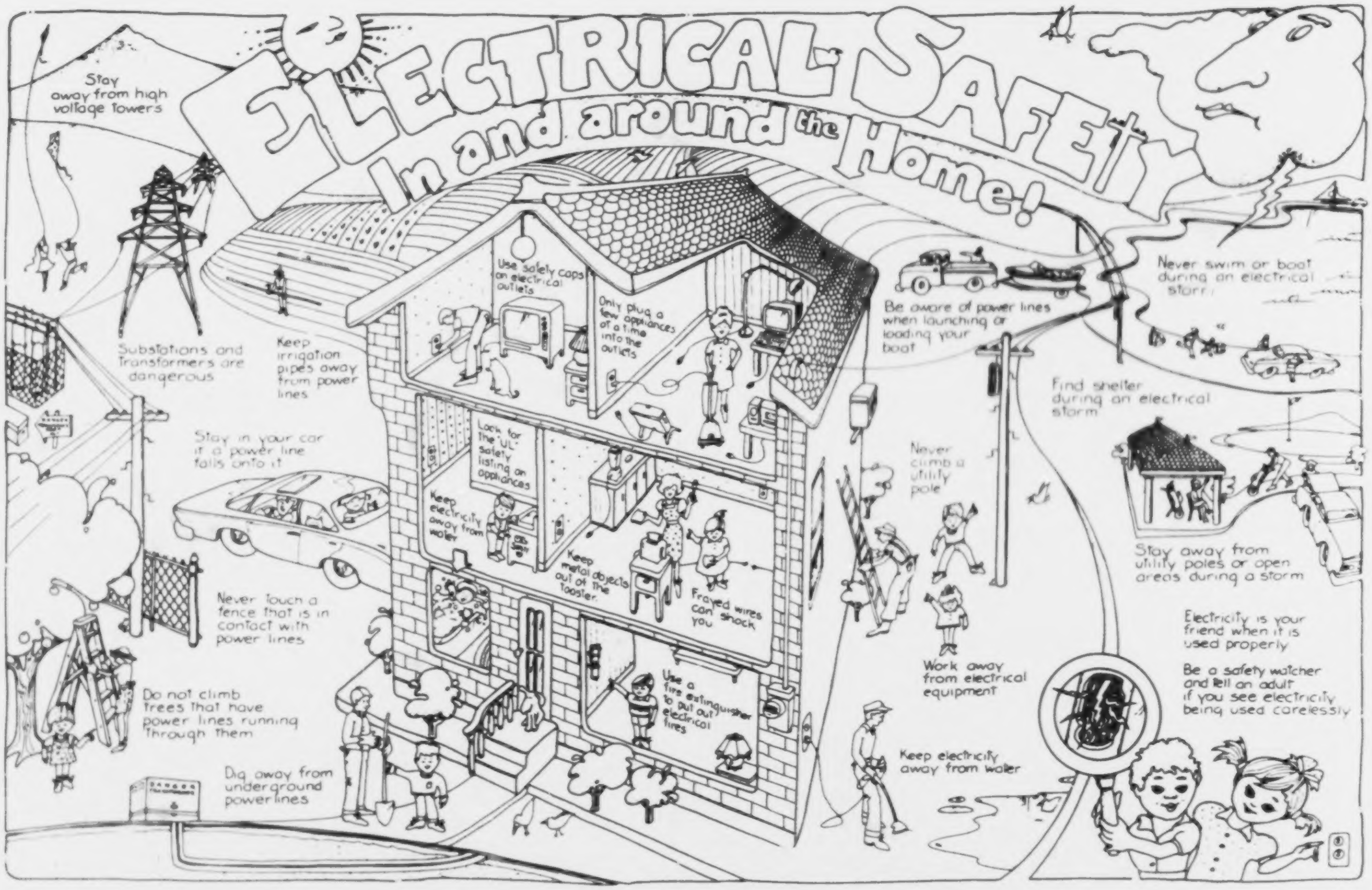
____

Teacher's Name


I'm an Electrical
SAFETY
WATCHER

I'm an Electrical
SAFETY
WATCHER

This art work is available as a full-color 23" x 35" poster from the National Energy Foundation, 5160 Wiley Post Way, Suite 200, Salt Lake City, Utah, 84116 Phone number: (801) 539-1406.


ELECTRICAL SAFETY
In and around the Home!
Stay away from high voltage towers
Substations and transformers are dangerous
Keep irrigation pipes away from power lines
Stay in your car if a power line falls onto it
Never touch a fence that is in contact with power lines
Do not climb trees that have power lines running through them
Dig away from underground powerlines
Use safety caps on electrical outlets
Only plug a few appliances at a time into the outlets
Look for the "UL" safety listing on appliances
Keep electricity away from water
Keep metal objects out of the toaster
Frayed wires can shock you
Use a fire extinguisher to put out electrical fires
Be aware of power lines when launching or loading your boat
Never swim or boat during an electrical storm
Find shelter during an electrical storm
Never climb a utility pole
Stay away from utility poles or open areas during a storm
Work away from electrical equipment
Keep electricity away from water
Electricity is your friend when it is used properly
Be a safety watcher and tell an adult if you see electricity being used carelessly

BEST COPY AVAILABLE

A Bright Idea

Activity
11

Science	Conversions	Grades	Time
		4-6	**60 min.**

Concept

Energy occurs in many forms.

Activity Goal

The students will study an example of potential energy converted to energy in the forms of heat and light.

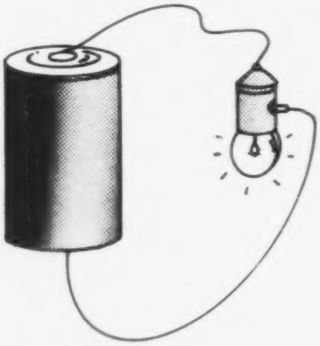
What You'll Need

- Several general purpose D-cell batteries
- Pattern for battery holder
- Brass paper fasteners or "brads"
- Pieces of insulated wire
- Rubber bands
- Screwdrivers
- Small flashlight bulbs and sockets

What To Do

1. Demonstrate a battery-operated toy with and without the battery. Explain that energy is the ability to move an object. Energy also lights light bulbs.

2. Explain to the students that the battery contains stored energy, or energy that has not yet been used. This is called potential energy. Show the students how to tap the energy from the battery by hooking up the wires to the battery and light bulb. Discuss each step you perform, since the students will be asked to do the same in small groups.



Explain to students that when the light is on, energy (electricity) is being used to do work (move electrons to make light and heat). While the light bulb is on, discuss:

A. How we know the energy from the battery is working.

B. What kinds of energy the bulb is giving off.

C. That the battery converts chemicals (chemical energy) to electricity (electrical energy) and that the light bulb converts electricity to light and heat energy.

3. Have students assemble their own battery holders, using the pattern and instructions provided. If enough materials are available, have the students form groups of four or five. Give them the materials needed to perform the activity in step two, following your instructions.

As the students do the activity, have them note the light and heat energy given off.

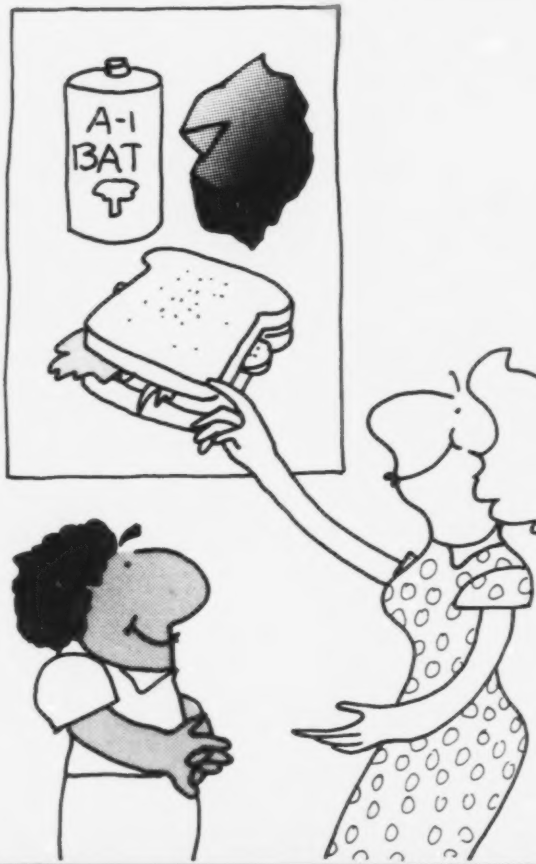
4. Give students examples of types of potential and active or kinetic energy.

Kinetic energy

a person riding a bicycle
a fire in a wood-burning stove
a person running
a moving automobile

Potential energy

a lump of coal
a battery
a sandwich
a rock at the top of a hill



Career Awareness Idea

Have an electrician or electric utility employee visit the class to discuss his or her job.

Evaluation Idea

Fill in the blanks using the words below:

1. A battery converts chemical energy into __________ energy.

2. Electricity is a form of __________ energy.

3. The light bulb converts electrical energy into __________ and __________ energy.

4. A battery contains __________ energy.

Word choices:

Electrical, Heat, Kinetic, Light, Potential

Answers:

1. Electrical
2. Kinetic
3. Light, Heat
4. Potential

ASSEMBLING YOUR OWN BATTERY HOLDER

Name ______________________________

Date ______________________________

1. Cut out the rectangle.

2. Cut out the rectangle on the dotted lines marked "cut." You'll be making four cuts.

3. Fold the rectangle on the solid lines marked "fold." You'll be making four folds.

4. On one end of the rectangle, place blocks B and A on top of block C.

5. Using a brass paper fastener or "brad," punch a hole through the centers of A, B, and C.

6. Fasten the brad so that its "head" will be inside the box and its "arms" are on the outside.

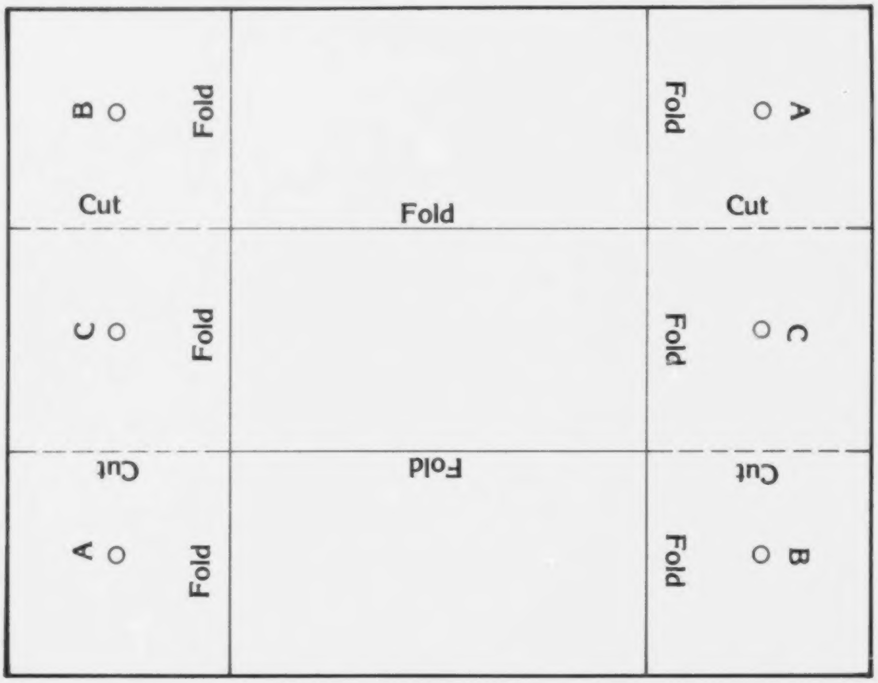
7. Repeat steps 4, 5, and 6 at the other end to finish the box.

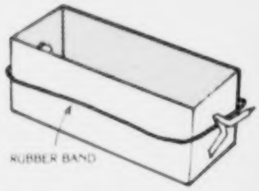
8. Wrap a piece of wire that has been stripped at the ends around the "arms" of each brad.

9. Place a battery in the box.

10. To keep your battery snugly in place, stretch a rubber band over the box from end to end.

11. Congratulations! You've just constructed a battery holder.





Food, Energy, and You

Activity
12

	Conversions	Grades	Time
Science, Mathematics, Language Arts		4-6	**7x30 min.**

Concept

There are man-made and natural energy conversion systems.

Activity Goal

The students will keep track of the number of calories consumed in their school lunches and become aware that food is converted to energy in their bodies.

What You'll Need

- 1/2 peanut (shelled) and an equal amount of walnut
- Postage scale or other small scale
- Cork
- Thermometer
- Straight pin
- Small tin can
- Aluminum foil
- Wire coat hanger or stiff wire
- Safety matches or butane lighter
- Calorie counter (booklet)

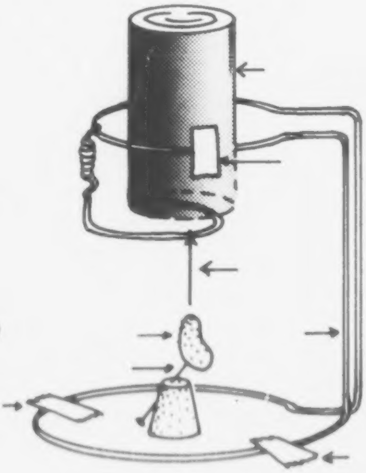
What To Do

1. Teacher Demonstration: Food Has Energy!

A. Using a small scale, weigh the peanut and walnut to verify they are the same weight.

B. Cover cork with aluminum foil. Stick a straight pin through the side of the cork and then into the peanut.

C. Bend wire coat hanger to make a frame for the tin can. Tape wire to tin can and to table for added stability.



D. Put cork and peanut 2 cm from the tin can. Add books or cardboard to raise the cork, or bend the frame down lower.

E. Fill the tin can 3/4 full of cold water. Record the temperature.

F. Set fire to the peanut, and record the water temperature after burning.

G. Starting with cold water again, repeat steps E and F using the walnut.

Discussion:

--Explain that nuts and seeds are high calorie/high energy foods to support growth of new plants.

--Ask students which nut raised the water temperature more. (Have students support their answers.)

--Ask students if food has energy. Where does the food's energy come from?

--Define the term calorie. (Calorie: a unit of heat energy equal to the amount of heat that will raise the temperature of one gram of water one degree Celsius.)

2. Class project:
Counting Calories

A. Using a calorie counter, keep track of calories consumed in school lunches for one week. Record them on a chart. Have students make a chart similar to the one shown below.

B. Discuss with students how our bodies use food's energy; to keep us warm, for growth, and for movement.

C. Have students name ways energy is used to bring food to the lunchroom: farming, processing, packaging, transporting, storing, cooking. Then have them select favorite foods and develop diagrams showing the energy used to put them on the table.

Career Awareness Idea

Have students interview the school dietician about his/her job in preparing food; specifically ask about planning healthy meals.

Evaluation Idea

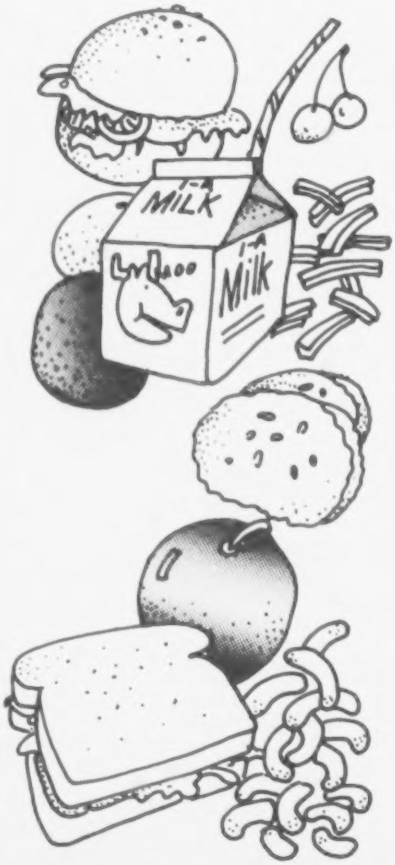
Ask students the following questions:

1. Where does food get its energy?

2. How is energy used to bring food to people?

3. How does the body use energy?

4. What are some human and natural energy conversions needed to get food to you?



Day	Lunch (List only foods you ate)	Calories
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		
	Total	

Wet, Windy, and Steamy

Activity
13

	Conversions	Grades	Time
Science, Art		**4-6**	**5x30 min.**

Concept

There are man-made and natural energy conversion systems.

Activity Goal

The students will construct a model water wheel, steam turbine, and windmill, and will state how these might be used (full scale) to run a generator to produce electricity.

What You'll Need

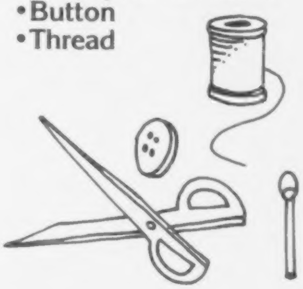
- "Electrical Generation Worksheet" for each student

Class Activity:

- Faucet and hose if available; if not use a large pitcher of water
- Tub or receptacle to catch falling water
- Burner or range
- Tea kettle or pan with lid
- Model water wheels and steam turbines made by students in investigations

The Power of Water

- Lightweight tagboard or side of a 1/2 gallon milk carton
- Scissors
- Toothpick or match
- Button
- Thread



The Power of Steam

- The cover of a round box, such as an oatmeal box
- Heavy duty aluminum foil (a piece about 7.5 cm long and 5 cm wide)
- A snap fastener, the kind without a hole in the middle
- A needle
- A pencil with an eraser
- An empty thread spool
- A stapler
- A tea kettle or pan with a lid
- A stove or burner

The Power of Wind

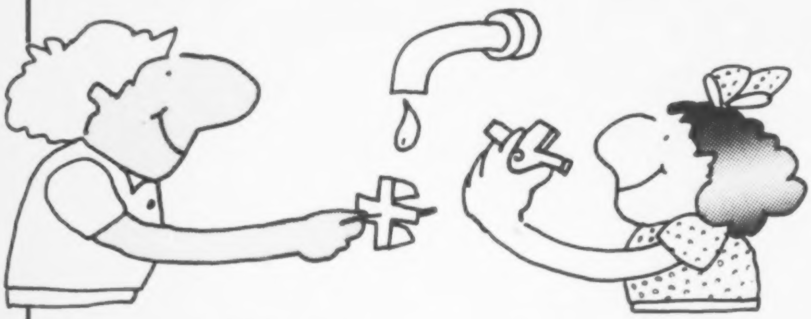
- A turbine made in "The Power of Steam"

What To Do

1. Provide students with copies of the three investigations: "The Power of Water," "The Power of Steam," and "The Power of Wind," found on the Electrical Generation work sheet. Have the students complete each investigation.

2. Review with the class the findings of their investigation with water, steam, and wind. Ask if any came up with ideas for how water or steam might be used to generate electricity. Allow time for discussion. Ideas by students can be put on the board for the class to discuss.

A. Discuss with the students the energy conversions that take place in the water and steam investigations. Remind them that the purpose of these investigations is to come up with a way to generate electricity. They should realize that in order to generate electricity, they must convert energy from one form to another. For



example, in the steam experiment, there are several conversions that take place:

- Electrical to thermal (the range heats the water)
- Thermal to physical (water boils to steam)
- Physical to mechanical (steam turns the turbine)
- Mechanical to electrical (turbine runs generator)

Talk about energy that must be put into the system in order to come up with electricity.

B. Discuss the wind investigation. Ask students to compare this method with each of the others. What might be possible advantages?

3. Ask for volunteers to help with an experiment. One student will hold a hose over a tub or sink and several other students will be needed to hold their water wheels beneath the stream of water.

A. First, experiment with the height of the water. Ask students to observe closely while you place the water wheel in different places under the falling water. Does it seem to make a difference in the speed that the wheel turns?

B. Next, ask students whether they think we are using all of the power of the water to turn the water wheels. Could we turn more than one?

C. Have volunteers add their water wheels one by one to the stream of water to see how many wheels they can turn with the water. Does the speed of the wheels turning change by adding more wheels? When you have as many wheels turning as possible, ask students if they are now using all of the power available. How do they know?

D. Ask: What happens to the water that is not being used to turn the wheels? Where does it go? Is there any way that this water can be used again? How? Ask how many students have visited a dam where a power plant is located. What happens to the water once it goes over the dam?

4. Heat water in a tea kettle and use the same procedure as with the water wheels, using the steam from the kettle and the model turbines built by the students.

A. Ask: Are we using all of the steam available to turn the turbines? How do you know? You might have a student hold his/her hand above the turbines to see if he/she can feel steam as evident that steam is escaping.

B. Ask: Is the wasted steam wasted energy? What happens to the steam that is left over? Is there any way that we can use this steam to do work for us? Can we re-use the steam? Is there any other kind of energy produced that might be used (heat)? How might it be used? Do you think that either the steam or the heat have any affect on the environment?

Career Awareness Idea

Invite a local electric utility person to class or someone who has information about steam and wind power generation to demonstrate or discuss how these sources of energy might be used on a large scale.

Evaluation Idea

Choose the correct conversion to fit the example.

A. Electrical to thermal
B. Thermal to physical
C. Physical to mechanical
D. Mechanical to electrical

____ 1. Water boils to steam.
____ 2. A turbine runs a generator.
____ 3. An electric range heats the water.
____ 4. Steam turns a turbine.
____ 5. Water wheel is turned by falling water.
____ 6. Coal is burned to boil water.
____ 7. Wind turns a windmill.
____ 8. Water from a dam turns a turbine.
____ 9. Atoms give off heat energy during a nuclear reaction to boil water.
____ 10. Steam turns a pinwheel.

Answers

1-B, 2-D, 3-A, 4-C, 5-C, 6-B, 7-C, 8-C, 9-B, 10-C

ELECTRICAL GENERATION WORKSHEET

Name ______________________

Date ______________________

You probably know that most of the electricity we use is brought to our homes by power lines which carry electric current. Where does the electric current come from? It comes from huge power plants where electricity is generated in large amounts for our use. To generate electricity requires a generator, and a generator needs a magnet, a coil of wire, and either the magnet or the coil must move.

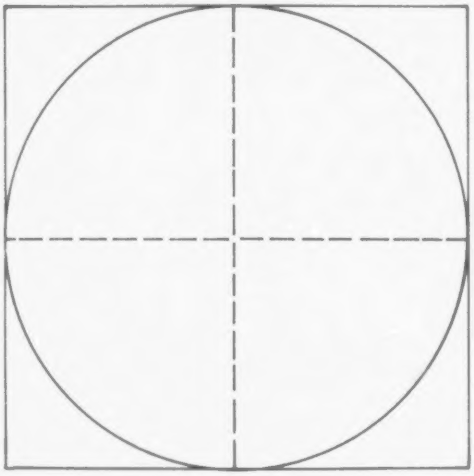
When you generate electricity with a hand generator, you use the energy of your muscles to turn the crank. How are generators in power stations turned?

Here are some simple investigations you can do to see some ways that generators might be turned in a huge power station:

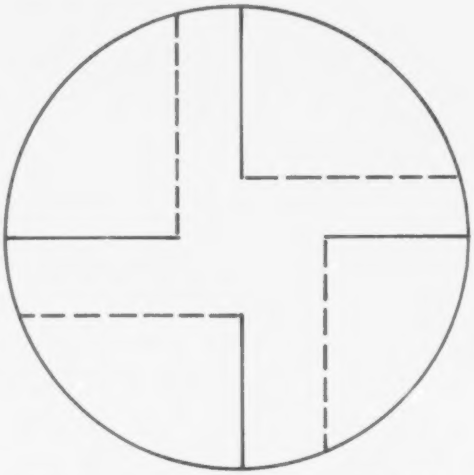
1. "The Power of Water." Refer to the Materials Section for a list of needed items. Follow the directions below:

A. Cut a circle about 10 cm in diameter from the tagboard.

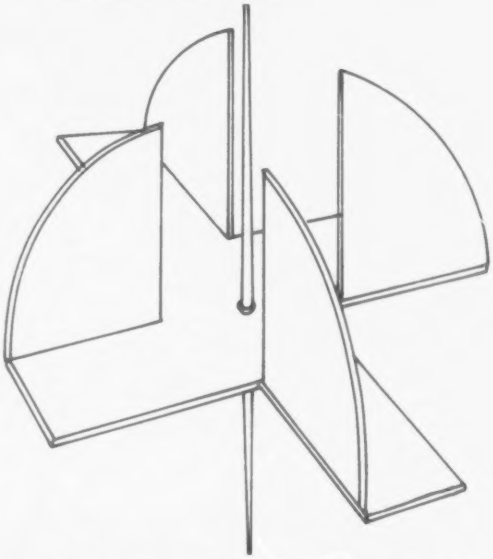
B. Make two lines on the circle, as shown in the sketch.



C. Cut part way down the lines and bend the flaps.



D. Sharpen the toothpick or match at both ends, then stick it through the center of the circle.



E. Hold the wheel lightly by the ends of the toothpick in one hand so that the points of the toothpick are between your thumb and middle finger.

F. Hold the wheel under a faucet and slowly turn on the water. What happens to the wheel?

G. Now turn on the water full force. Watch the wheel. Where did it get the power to turn?

H. Where did the water get the power to turn the wheel?

I. Now you can make your water wheel do some work for you by tying a button to one end of a piece of thread and tying the other end of the thread to the toothpick. Now hold the wheel under the running water. What happens to the button and thread?

J. Using what you learned about the power of falling water in this investigation, describe a way that water might be used to generate electricity.

____

____

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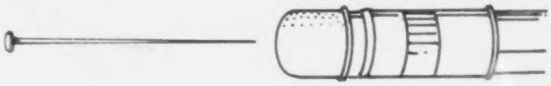
2. "The Power of Steam." Refer to the Materials Section for a list of needed items. Follow the directions below:

A. Cut the foil into eight pieces, each 7.5 cm long and 5 cm wide. Fold each piece in half.

B. Staple each piece to the box cover.

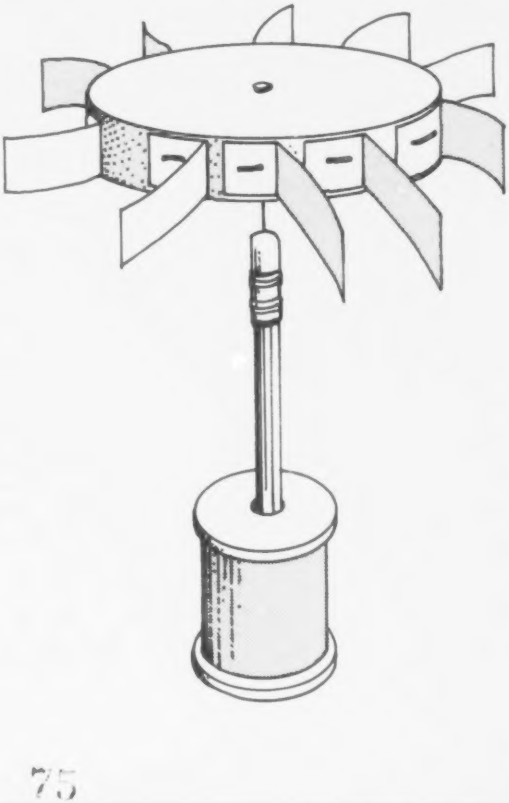
C. Push the eye end of the pin into the eraser of the pencil.



D. Put the box cover on the point of the needle. Experiment until you find the place where the cover hangs straight and even. Make a tiny hole at this place.

E. Push the bottom half of the snap fastener into this hole.

F. Put the point of the pencil into the hole in the spool.



G. Rest the box cover on the point of the needle.

H. Put some water in a tea kettle or pan with a lid and heat it until it boils. (If you are using a pan with a lid, place the lid slightly off center so that the steam pushes out strongly on one side of the pan.)

I. Hold the device you made by the spool and bring it near the steam from the kettle. What happens?

J. Where does the wheel get the power to turn?

K. Where does the steam come from?

L. Where did the water get the heat that made it boil to make the steam?

M. Where did the heat come from? What was the energy source used to heat the water?

N. Using what you have learned about the power of steam, describe a way that steam might be used to generate electricity.

3. "The Power of Wind." Use the device you made in the second investigation. Follow the directions below:

A. Hold your miniature turbine in one hand and blow on it gently. What happens?

B. Blow hard on the wheel. What happens?

C. What makes the wheel turn? Where did this power come from?

D. Using what you have learned about the power of moving air, describe a way that wind might be used to generate electricity.

Water to Electricity

Activity
14

	Conversions	Grade	Time
Mathematics, Science		**4-6**	**2x45 min.**

Concept

There are man-made and natural energy conversion systems.

Activity Goal

The students will compute the amount of water (in liters) required to operate various electrical appliances for given periods of time.

What You'll Need

- "Water to Electricity" work sheets for each student
- "How to Read Your Meter" work sheet for each student
- "Reading your Electric Meter" work sheet for each student

What To Do

1. Inform students that electricity (electrical energy) is a form of energy produced from the conversion of an energy source: coal, oil, natural gas, uranium (nuclear) or water (hydroelectric).

A. Explain how fossil fuels (coal, oil, natural gas) and uranium are converted to generate electricity.

2. Fossil fuels. Coal, oil, and natural gas are burned to produce heat energy. The heat energy is used to turn water into steam. The steam, under pressure, is used to turn a turbine. The spinning turbine causes the magnets in the generator to spin, inducing an electric current.

3. Nuclear. The process is similar in nuclear reactors, except uranium atoms fission (split) producing the heat energy used to turn water into steam.

B. Explain how water is used to generate electricity.

4. Provide students with a copy of the Hydroelectric Dam illustration or make an overhead transparency. (Please refer to following pages)

5. Discuss that hydroelectric dams are built to control the flow of water and to increase the water pressure. Water pressure is related to the depth of the reservoir. The greater the water pressure, the greater the power. Water flows through the dam in pipes, called penstocks. The water is applied to a turbine, which spins a generator producing electricity.

6. Inform students that it requires approximately 16 liters of water falling 30 meters to produce one watt-hour of electrical energy, or about 16,000 liters to produce one kilowatt-hour of electricity.

7. Pass out the student work sheet "Water to Electricity" and have students complete the questions. You may wish to make this a homework assignment.

8. In order to complete this part of the activity, the student must learn how to read an electric meter. Pass out copies of "How to Read Your Electric Meter" and go over it until all students understand how to read their electric meter.

9. Provide students with a copy of "Reading Your Electric Meter," and have them complete the activity.

10. Have the students share and discuss their results.

11. Discuss the following questions:

A. Why do the amounts differ from student to student?

B. How might the number of people in the family influence energy consumption?

C. What were some ways your family used electricity during the week?

12. Have the students suggest ways they might conserve energy.

Career Awareness Idea

Invite a local utility worker to class to explain his/her job and how water is converted to electricity.

Evaluation Ideas

1. Have students explain how water is converted to electricity in hydroelectric dams.

2. Have students explain how water is used to generate electricity in coal, natural gas or oil-fired power plants.

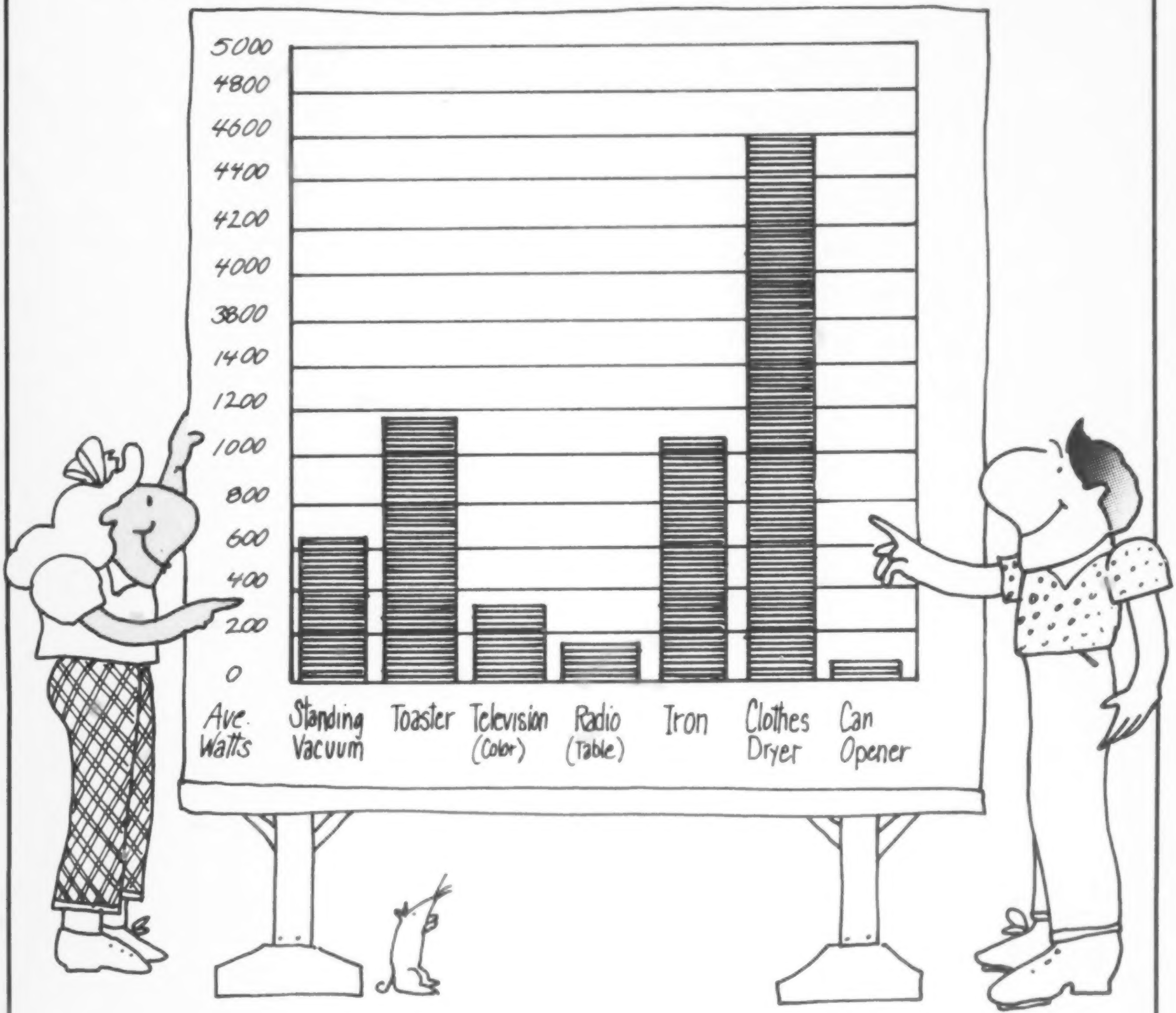
WAYS TO CONSERVE
ENERGY
1
2
3
4
5
6

WATER TO ELECTRICITY

Name ______________________

Date ______________________

1. Study the bar graph below and answer the following questions:



A. Which appliance shown on the graph requires the greatest amount of electricity for its operation?

____

B. Which appliance requires the least amount of electricity?

____

C. Which appliance is used most often in your home?

____

D. Which appliance do you consider to be most important to your family?

____

E. Which appliance do you think your family could do without?

____

____

F. How many watts of electrical energy are required to operate the electric can opener?

____

1. How many liters of water would have to pass over a 30 meter high dam to operate the can opener for one hour?

____

G. How many watts of electrical energy are required to operate the clothes dryer?

____

1. How many liters of water must pass over the dam to operate the dryer for one hour?

____

2. For three hours?

____

____

H. Compute the equivalent number of liters of water required to operate each of the other appliances for one hour.

____

____

____

I. Assume that all of the appliance shown on the graph were being used in your house at the same time. How many liters of water would be required to produce electricity to operate the appliances for one hour?

____

2. Explain how water is used to generate electricity in a hydroelectric dam.

____

____

____

3. How is water used in a coal, oil or natural gas power plant to generate electricity?

____

____

4. What determines how much power is available to generate electricity from hydroelectric dams?

____

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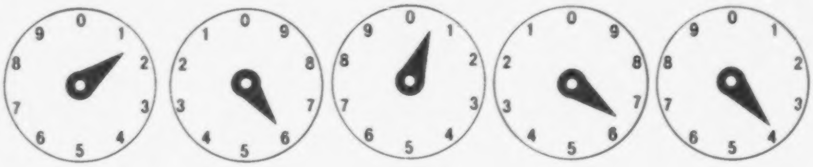
HOW TO READ YOUR ELECTRIC METER

Name ______________________

Date ______________________



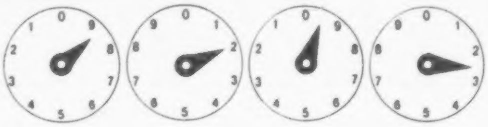
The dials are like watch faces lined in a row (every other dial moves counterclockwise). The reading for a five dial meter would be 16,064. The reading for a four dial meter would be 6,064.

Notice that when the pointer is between two numbers, you should record the lower of the two numbers.

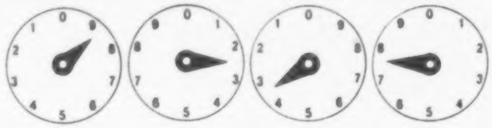
When the pointers seems to be directly on a number, look at the dial to the right; if the pointer on the right side of the dial has passed "0," then write down the number the pointer seems to be on; if the pointer on the right side dial has not passed "0," then write down the previous lower number on the dial you are recording.

Record the Readings for the Following Meters:

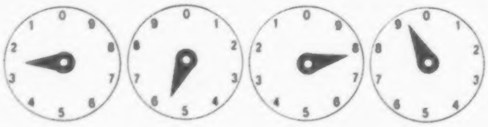
Row A1



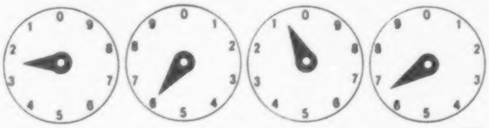
Row A2



Row B1



Row B2



Subtract the number of line A from the number on line B to find the number of kWh of electricity used.

Row A1 ________ Row A2 ________

Row B1 ________ Row B2 ________

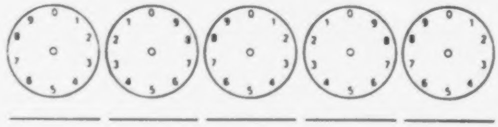
kWh ________ kWh ________

READING YOUR ELECTRIC METER

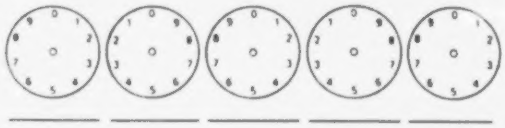
Name ____________________

Date ____________________

Record the reading on your electric meter for each day. Be sure to read your electric meter at the same time each day.



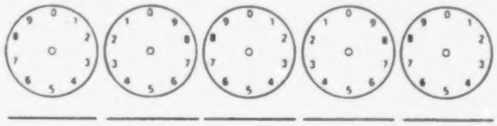
Meter Reading Day 1 ________



Reading Day 2 ____________

Reading Day 1 ____________

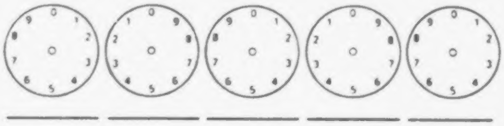
Energy Used ____________



Reading Day 3 ____________

Reading Day 2 ____________

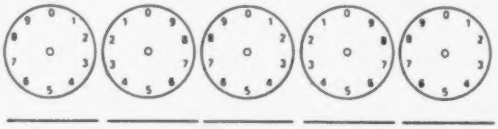
Energy Used ____________



Reading Day 4 ____________

Reading Day 3 ____________

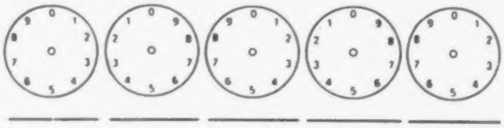
Energy Used ____________



Reading Day 5 ____________

Reading Day 4 ____________

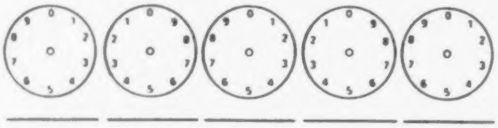
Energy Used ____________



Reading Day 6 ____________

Reading Day 5 ____________

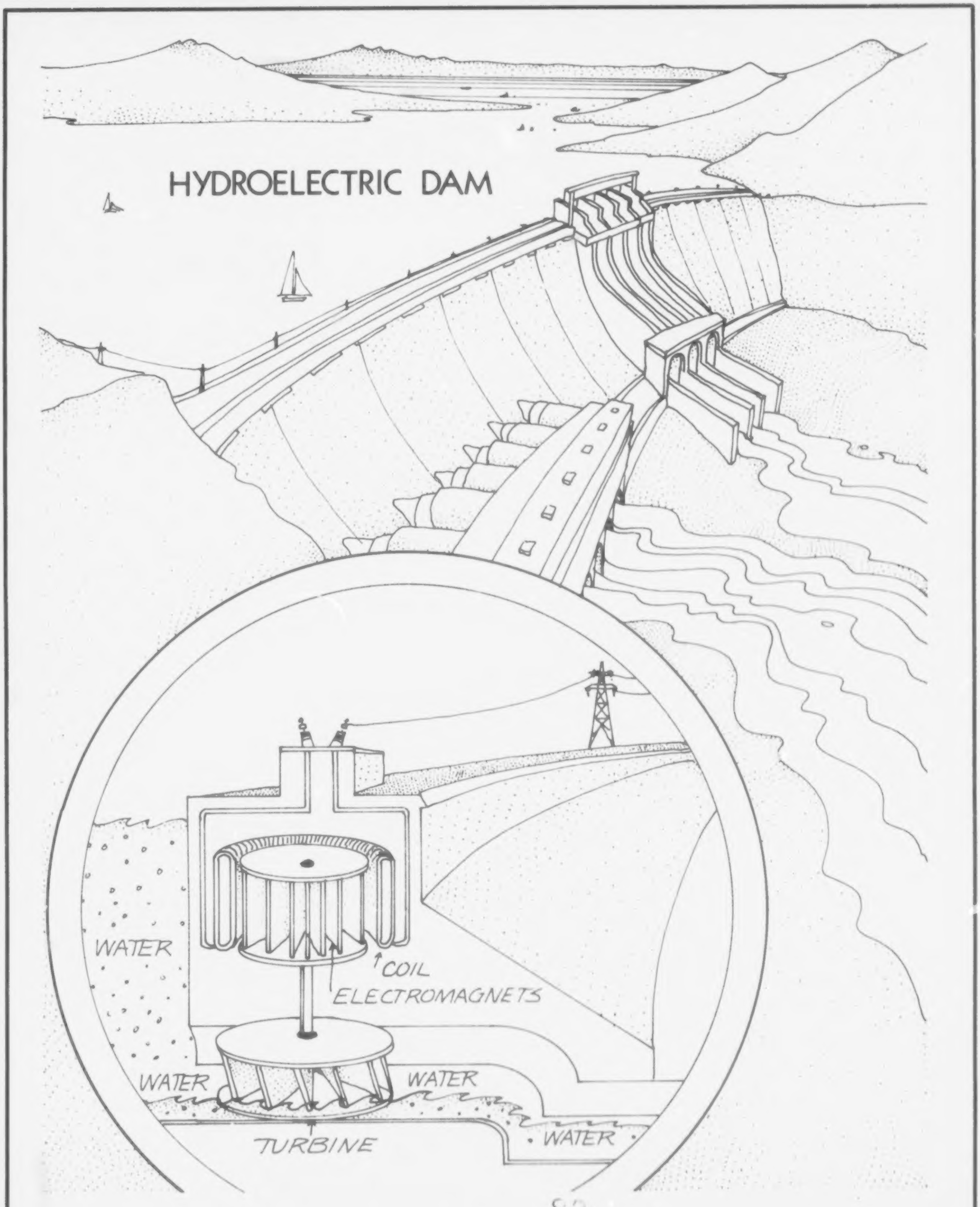
Energy Used ____________



Reading Day 7 ____________

Reading Day 6 ____________

Energy Used ____________


HYDROELECTRIC DAM
WATER
COIL
ELECTROMAGNETS
WATER
WATER
TURBINE
WATER

BEST COPY AVAILABLE

Energy for Electricity

Activity
15

	Conversions	Grades	Time
Science		**4-6**	**60 min.**

Concept

There are man-made and natural energy conversion systems.

Activity Goal

The students will observe an artificial conversion system.

What You'll Need

- Tea kettle
- Hot plate
- Pinwheel
- Cooking or scientific thermometer
- Beaker or can
- Energy for Electricity Puzzle - one for each student

What To Do

1. Explain to the students that one form of energy can be changed (converted) to another. For example, the energy of coal, natural gas, or oil can be converted to heat energy. Have students share what they know about steam. Name various uses for steam such as steam heat for buildings, steam engines, or the use of steam to produce electricity. Ask students what was converted to make steam.

2. Teacher Demonstration: Using a hot plate, boil water in a tea kettle. As the steam rises place a pinwheel in the path of the steam. Explain that the heat energy was used to boil the water to create steam. The force of the steam moves the pinwheel.

Discussion:

A. How long did it take the water to boil?

B. How long did it take the wheel to begin turning?

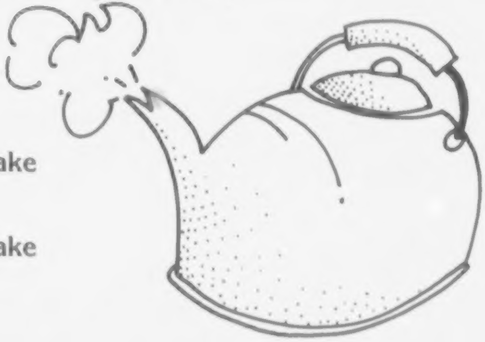
C. How long does it continue turning after the energy has been turned off?

D. What happens to the heat energy produced by the hot plate?

E. Is all the steam being used to turn the wheel?

F. Ask the students where the hot plate gets its energy?

3. Tell students how heat is used to generate electricity: Coal, oil, or natural gas can be burned to produce heat energy. The heat energy is then used to turn water into steam. The steam is then used to turn a turbine (a pinwheel-like machine), which spins a generator (made of magnets and coils of wire). The generator produces electricity.



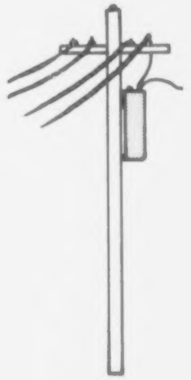
Evaluation Idea

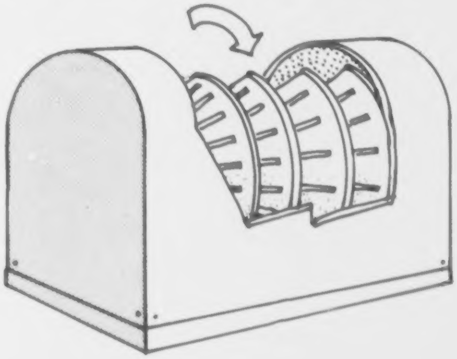
Give students the "Energy For Electricity Puzzle." Have students cut along the dotted lines. Lay the pieces in the correct order to show electrical generation, distribution, and use.

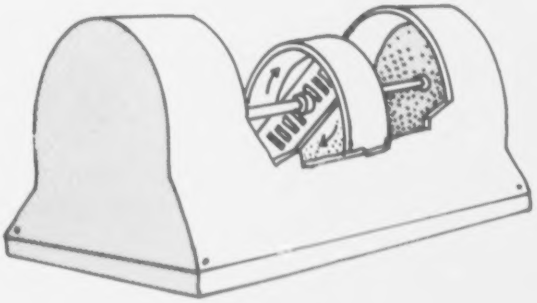
ENERGY FOR ELECTRICITY PUZZLE

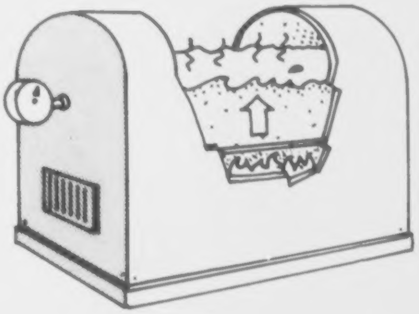
Name ______________________

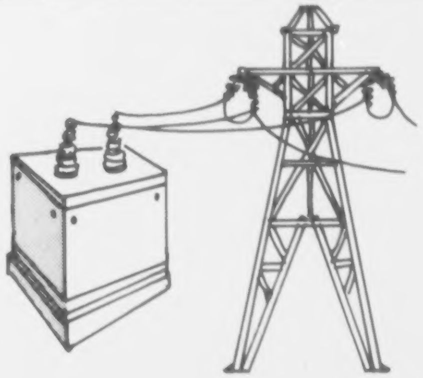
Date ______________________

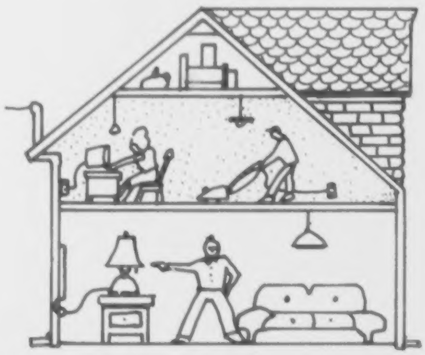












Solar Collectors

Activity
16

	Conversions	Grades	Time
Science, Mathematics, Art, Language Arts		**4-6**	**3x45 min.**

Concept

The efficiency of energy conversion systems differs.

Activity Goal

The students will explain that solar collectors of different colors and absorption mediums will convert solar energy to heat energy at different efficiencies.

What You'll Need

- Various colors of poster paint - flat, not glossy
- At least 8 cans the same size
- Plastic wrap
- Tape
- Dirt, sand, gravel, styrofoam, saltwater to fill cans
- Thermometers

What To Do

1. In small groups have students select a color (black should be one of the colors) from those available and paint a can. The cans should be of the same size.

2. Fill each can half full of cold water and cover with plastic wrap. Use tape to hold plastic wrap in place. Insert a thermometer to measure the temperature of the water. Place cans in the sunlight for several hours. Measure water temperature at 30-minute intervals and the first thing the next morning.

3. Students will then prepare graphs to plot temperature against time, at 30 minute intervals. See sample graph below.

4. Repeat the above using different heat storage mediums: dirt, gravel, sand, saltwater, styrofoam. Use unpainted cans.

5. Discuss with students the results of the investigations. Ask:

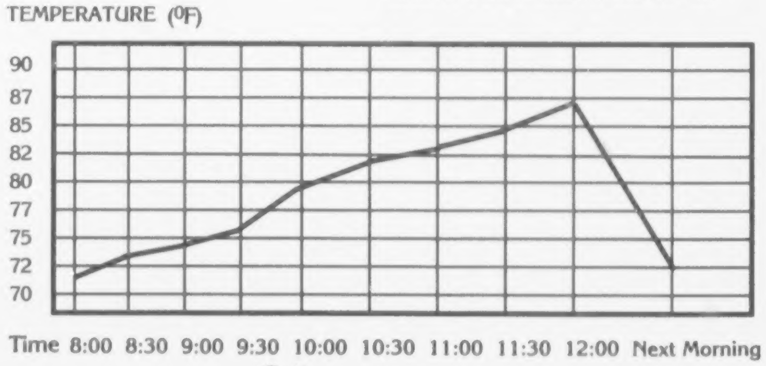
A. Which color(s) absorbed the most heat energy? Why?

B. Which storage medium absorbed the most heat energy? Why?

C. Which color and storage medium retained its heat energy the best?

D. Which system is the most efficient?

E. What combination of color and storage medium would you think absorbs and retains the most heat?



F. How might you use what you have learned in the investigations to obtain energy for use in your home?

6. Divide students into groups to research one of the following solar energy technologies and prepare an oral report. They should include drawings, describe how the technology works, its feasibility, how the sun is used and other advantages and disadvantages.

A. Solar ponds

B. Power towers

C. Ocean thermal energy conversion systems

D. Photovoltaics

E. Passive solar technologies

F. Active solar technologies

G. Wind energy

H. Tidal energy

Career Awareness Idea

Invite a speaker who works in the area of solar energy to speak to the class about his/her job.

Evaluation Idea

Have the students explain how they would apply what they have learned from the investigations to heat water for their home.

87

Save Our Environment

Activity
17

	Impacts	Grades	Time
Science, Art	🍃	**4-6**	**2x30 min.**

Concept

Energy resource development and use impact environmental conditions.

Activity Goal

The students will identify environmental concerns and solutions.

What You'll Need

- Environmental mini-posters for each student
- Crayons or markers
- Newspapers

What To Do

1. Introduce the activity by explaining that there are many environmental issues and concerns in the news today. Discuss examples and ask the students to look for one example in their daily newspaper and bring it to class. Have the students share their examples with the class.

2. Challenge the class to brainstorm and think of ways to solve the environmental issues. (This could require the students researching the topic.)

3. Give an environmental mini-poster to each student. The mini-poster is divided into two sections. In one section draw a picture representing the environmental issue or concern of their choice. In the second section, draw a picture to represent the solution or a way of protecting the environment.

4. Have the students decorate, color, and title their mini-posters.

5. Have the students discuss their mini-poster with the rest of the class and display them on a bulletin board.

Evaluation Idea

Have the students name three ways they can help protect the environment.

Burning Releases Energy and Waste

Activity 18

Science	Impacts	Grades	Time
	🍃	4-6	45 min.

Concept

Energy resource development and use impact environmental conditions.

Activity Goal

Students will learn that the burning of fuels produces not only heat and light, but wastes, too.

What You'll Need

- Candle
- Match

What To Do

1. Teacher demonstration:

Burn a candle and/or a match and ask the students to make observations about what is produced. (Burning produces heat and light energy as well as waste in both solid and gaseous form.)

2. Explain that much of the energy we use every day comes from burning energy sources like coal and oil products (fossil fuels). Along with the heat and light produced - which we use to do things like make electricity and run cars - wastes are produced. (Students who have fireplaces and wood stoves will be familiar with this.)

3. Discuss with the students why it is important to keep these wastes from harming the air and water. Explain how energy conservation can help protect the environment.

Evaluation Idea

Have students name two ways energy conservation can protect the environment.

Recycling Round-Up

Activity
19

Science	Impacts	Grades	Time
	🍃	4-6	60 min.

Concept

Energy resources development and use impact environmental conditions.

Activity Goal

The students will identify items that can be recycled and participate in a clean-up hunt.

What You'll Need

- 2 garbage bags for each team
- 3-4 large, sturdy boxes
- Clean-up list for each team

What To Do

1. Discuss with the students about waste and recycling and how they affect the environment.

2. Divide the class into several teams. Each team should consist of 5 to 8 students.

3. In teams, have the students make a list of items they might find on the school grounds that would be considered litter, and possibly could be recycled.

Suggestions might include the following: newspapers, soda pop cans, candy wrappers, plastic bottles, paper sacks, pencils, paper clips, rubber bands, etc.

4. Have the students divide their list into two categories:
   Garbage
   Recyclable Items

5. Tell the students they are going to participate in a "recycling round-up." Each team will have two garbage bags, and a clean-up list.

6. Allow the students approximately 20 minutes to look for the items on their lists. The team which finds the largest number of listed items is the winner.

7. Have the students sort all of the items, disposing of the litter properly and keeping the items that can be recycled.

8. Discuss where recycled items can be taken in your area. (The local city sanitation department can instruct you for your area.)

9. Encourage the students to be aware of items at home that can be recycled instead of thrown away. You might have them bring items from home that can be recycled and collect them as a class project.

Career Awareness Idea

Invite a representative from your local city sanitation department to discuss the value of recycling and what happens to the items that are recycled.

Evaluation Idea

Have the students list several items that can be recycled. Discuss in class alternative methods of trash disposal.

Select A Site

Activity
20

	Limits	Grades	Time
Science, Mathematics	🌐	**4-6**	**60 min.**

Concept

Energy resources are unevenly distributed.

Activity Goal

The students will understand how coal resources are deposited.

What You'll Need

- Graph paper
- Reference book containing map of U.S. coal deposits
- Chocolate chip cookie for each student
- Napkin for each student
- Paper clip for each student

What To Do

1. Each student is given a cookie and a napkin. They are not to eat any part of the cookie at this time!

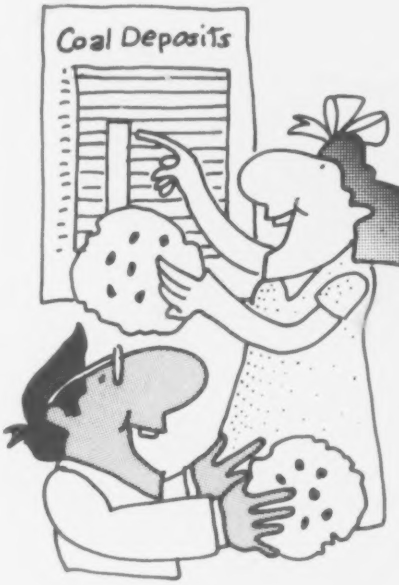
2. Tell the students that the cookie represents their country or state. The tan particles represent the earth's crust and the chocolate chips represent the coal deposits.

3. Instruct students to count how many visible chunks of coal are in their country. Count only the coal deposits visible from the top.

4. Provide students with graph paper and have the students create a bar graph to illustrate the visible chunks of coal for their country or state. Record class data on the chalkboard.

5. Now have each student predict how many coal deposits they think they have in their country or state.

6. Provide each student with a paper clip and instruct them to begin "mining" their coal deposits. Have them place their coal deposits in one pile and the earth's crust in another.



7. Next, have students count the coal deposits and prepare a bar graph next to their first graph. Record the class data on the chalkboard.

8. Compare and contrast the number of coal deposits visibly observed and actually in existence. How does the actual number of coal deposits compare to their predictions?

9. Discuss the following points with the class:

A. Our data tells us that there were more "coal deposits" than could be seen on the surface.

B. "Mining" the deeper coal took more time and was more trouble than mining coal near the surface. (It takes energy to get energy.)

C. "Mining" the coal has environmental impacts.

D. The coal deposits were unevenly distributed. Some students had more coal deposits than others.

10. Show the students a U.S. map of coal deposits which illustrates that some states have more coal deposits than others. Your school librarian should be able to assist you in locating a reference book with a map.

Evaluation Idea

1. What can you say about the distribution of energy?

2. True or false: It takes energy to obtain energy?

3. Can we get energy without impacting the environment? Explain.

A Happy Ending

Activity
21

Language Arts, Science, Social Studies,	Limits	Grades	Time
	🌐	4-6	2x45 min.

Concept

All energy resources have limits to their usefulness.

Activity Goal

The students will understand what nonrenewable resources are, and their limits.

What You'll Need

- The play: "A Happy Ending"

What To Do

1. Have a group of students perform the play "A Happy Ending."

2. Discuss the following after students have performed the play:

A. What is a nonrenewable resource? Renewable resource?

B. How are resources limited in their usefulness?

C. How might the depletion of resources affect one's lifestyle and environment?

3. Have students create an illustration of one of the dialogues and share it with the class.

Evaluation Idea

1. Why is coal, oil, and natural gas referred to as nonrenewable?

2. How are energy sources limited in their usefulness?

A HAPPY END-ING

A HAPPY ENDING

Name ____________________

Date ____________________

This play can be produced on a stage or as a radio program. It can be taped and played back to the class as another learning experience.

CHARACTERS

Aluminum
Coal
Copper
Iron
Natural Gas
Crude Oil
Concerned Citizen
Unconcerned Citizen
Announcer

ANNOUNCER: This is a make-believe story about the world's nonrenewable resources; that is, resources that cannot be replaced once they are used up. It could never happen in real life because nonrenewable resources cannot talk, but we think if they could, this would be what they would say to us.

Our story begins in a museum where aluminum, coal, copper, iron, natural gas, and crude oil are on display in a case labeled "nonrenewable resources."

COAL: Do you guys realize that I'm only going to be around for another century or two, and then I'll be all used up...I'll be all gone...depleted, if people don't change their ways?

ALUMINUM: Depleted! What in the world does depleted mean?

COPPER: That means used up and destroyed forever. I might be depleted too. That makes me very sad because I have done so much for people since I was discovered. Why, I am even put in money now because our friend silver is almost all gone.

IRON: Yes, I might be depleted sooner or later too.

NATURAL GAS: And I might be depleted someday too.

CRUDE OIL: I only have decades to go, too, if people aren't careful.

COAL: Wow, I never thought I'd see the day when our jobs might finally be over. And do you realize that none of us can be produced by people?

CRUDE OIL: Yes, and it took millions of years to make us, and we might be gone before you know it. I just wonder what people plan to do if we are all used up?

NATURAL GAS: Yes, so do I! I don't think people have even begun to realize what we do for them and what will happen if we are gone. Why, I help heat homes, cook food, help to run factories, dry clothes, heat water, and many more things.

COAL: Yes, I also heat and run homes, factories, schools, hospitals, office buildings, and many more things. I'm also used to supply big power plants with energy so that they can produce electric power for many homes, towns, and big cities. I'd like to see people use me wisely.

CRUDE OIL: How about me? Without crude oil, people couldn't run cars, buses, trains, planes, motorcycles, and any other thing with an engine in it. I also make cosmetics, paints, fertilizers, and many synthetic materials.

IRON: Without me people couldn't build skyscrapers and bridges, hospitals, schools, and churches. I just wonder if people know exactly what they are headed for?

COAL: I don't know, but here come two of them now. Why don't we ask them?

CONCERNED CITIZEN: (Walking toward the display of nonrenewable resources.) Boy, is this ever a nice museum! I really had no idea they could put so much material into a museum. Isn't it just great?

UNCONCERNED CITIZEN: Yeah, I guess so if you dig this sort of thing. Me, I'd rather be at the beach enjoying the sun and surf. Of course, with the gas shortage and all I can't drive to the beach, so I guess I'll have to settle for second best. That's life!

CONCERNED CITIZEN: Yes, that's life, but I just wonder if there isn't something we can do about it. You know, for years we have used all our natural resources without thinking that maybe someday they would be used up. I hope maybe it isn't too late to start doing something about it. I already am trying to conserve by turning my thermostat down, by riding my bike instead of driving my car, and driving 55 mph on the highway. But I'm sure there must be many more things I can do.

UNCONCERNED CITIZEN: Yeah, I suppose so, but I figure there are enough other people conserving that if I don't, it won't matter.

CONCERNED CITIZEN: Hey, look over there! There's a display of nonrenewable resources. Those are resources that can never be replaced. This ought to be interesting. Come on; let's go! (They walk over to the display and look down on it.)

COAL: Hello there. (The two citizens look around shocked, then focus their attention on the piece of coal.)

CONCERNED CITIZEN: Hey, did you hear that piece of coal say something?

COAL: Of course I said something. Isn't it about time we nonrenewable resources said something to the objects that are using us?

CONCERNED CITIZEN: Yes, I suppose so, but I just never thought I'd hear a piece of coal talking to me. I've used you for years to heat my home, but I certainly never carried on a conversation with you before!

COAL: That's the whole point! You've used us for years, but you never stopped to think and understand what is happening to us. Do you realize that all of us in this display case might be completely used up? Gone?

UNCONCERNED CITIZEN: Big deal! So what? Scientists have saved us before, so why can't they do it again? We don't need you, because I'm sure we'll find something else to take your place.

CRUDE OIL: This could very well be, but I wouldn't count on it. Scientists are now working on all sorts of forms of energy such as geothermal, solar, and nuclear energy, but they all have problems that have to be worked out. Besides, what you and so many other people don't realize is that all of us are used in a lot more ways than you can even imagine. Did you know that I'm used to make all of those beautiful synthetic fabrics we have today, and that without me our factories couldn't run to produce those materials?

ALUMINUM: Yes, and did you know that I am found in such things as doors, toys, car parts, boats, bicycles, rocket fuel, street signs, knitting needles, jewelry, Christmas tree tinsel, mobile homes, and many more things you haven't even thought about? Can you imagine how hard it would be to even start to find a replacement for all these things?

IRON: Yes, and do you realize how many jobs our industries provide for people? Why, we provide jobs for miners, architects, geologists, metallurgist, market analysts, bookkeepers, data processors, secretaries, personnel managers, advertising specialists, and many more.

COPPER: Hey, how about me? I carry electricity from generating plants to all our homes, schools, and businesses. I just wonder what will happen to people if all of us are used up. Do you have any ideas at all about what is going to happen?

UNCONCERNED CITIZEN: I never really thought about it before, but I just always thought that science would invent anything we needed. I never thought that maybe we would run out of the things we need to invent new things! That's really something to think about.

CONCERNED CITIZEN: You're right, and it's about time we started thinking about it and doing something about it. (Turning to the display of nonrenewable resource.) Do you guys have any suggestions?

ALUMINUM: Yes, I have one. Instead of throwing away things that are made out of me, such as used cans, old toys, aluminum doors, and many more things, save them and recycle them. You know some cities have places where you can sell me back again to be used over and over.

COAL: You can make me last longer by being very careful about using electricity. Don't run electrical appliances when it isn't necessary, turn out lights when you leave a room, turn down your thermostat, keep your house well insulated so heat won't escape, and never use electrical power unless it is really necessary. I'm sure you can think of many more things if you really think about it.

COPPER: I can also be recycled or used again just as aluminum can. I really wonder how much of me can be found in old junkyards and garbage dumps?

IRON: I too can be recycled and made into brand new things like car parts and parts for almost all kinds of machines and equipment.

NATURAL GAS: I can be conserved in the same way coal is; by taking it easy and being very, very careful with the things I help run. For instance, people can save natural gas by always running a full load of clothes in a gas washer and hanging their wash outside when possible instead of running their gas dryer. Also, you can save natural gas by always making sure your gas appliances are in perfect running order.

CRUDE OIL: I guess most people think of me when they think of cars, but I also do many more jobs. They make liquid gasoline, oil, and kerosene out of me. I help all kinds of machines work, I oil hinges in doors, and I run cars. If people drove 55 mph, only drove their cars when it was necessary, and rode in car pools to work, it would really help conserve me. I think we could all agree that we must all do all we can to help, because when everyone works together, things always seem to work out for the best.

CONCERNED CITIZEN: Yes, I agree completely, don't you? (Talking to his friend.)

UNCONCERNED CITIZEN: Well, I know one thing; I'm going to do all I can to help because I sure don't want to lose all our friends here. I wish I had started sooner, but maybe it's not too late.

CONCERNED CITIZEN: Yes, maybe it's not too late after all. If we all work together, we still can have a good world to live in.

Pass the Sack

Activity
22

	Limits	Grades	Time
Science, Social Studies	🌐	**4-6**	**45 min.**

Concept

Social decisions influence the availability of energy resources.

Activity Goal

The students will understand that some energy resources are nonrenewable, and that their use is limited by social decisions.

What You'll Need

- Peanuts, cheerios, or other small pieces of candy--enough for 1 1/2 times the class size.

What To Do

1. Count out enough candy so there is one piece per student. Put it in a paper sack. Save the remaining candy.

2. Before passing out the candy, review renewable and nonrenewable resources and give examples of each.

Renewable Resources

Wood
Water
Wind
Sun

Nonrenewable Resources

Coal
Oil
Natural Gas

While this discussion is taking place, pass around the sack of candy, without any rules about how many pieces students can take. Occasionally add four or five pieces of candy to the sack. The sack will be empty before it reaches all the students.

3. Point out that fossil fuels have limits just like the candy. Emphasize that fossil fuels are nonrenewable and are being consumed faster than they are replaced in nature. Explain how much harder students would have to search the room to find the rest of the candy. What if the rules did not allow students to leave their desks? Point out that natural gas, coal, and oil companies are looking harder for more resources. What affect did the availability of candy have on relationships between students? What affect might the availability of fossil fuels have on the relationships among nations, people, states, standard of living, and quality of life?

4. With the class, now plan to pass out the remaining candy. Should rules be established? Do oil, coal, and natural gas companies have rules (regulations) that they must follow to find resources? Should there be rules and regulations on how much oil, coal, or natural gas people use? How does the class's social decisions influence the availability of candy?

5. Pass out the rest of the candy according to the plan.

Evaluation Idea

How might social decisions influence the amount of energy available to people?

(Example: regulations on how much people use or regulations on drilling or transportation of resources)

Life-Styles in the Future

Activity 23

	Future	Grades	Time
Science, Social Studies, Language Arts	?	**4-6**	**2x60 min.**

Concept

Energy availability will affect future lifestyles and cultural conditions.

Activity Goal

The students will creatively write stories about the future and the role that energy availability will play.

What You'll Need

- Paper
- Pencil

What To Do

1. Discuss with the students the role that energy plays in our lives today.

2. Instruct the class to choose one of the following situations and finish the story. Remind them to include what they have learned about energy.

Situation #1
Imagine you are a mother or father of a teenager and a child in grade school. "It was a cold December morning in the year 2025. As we awoke..." (finish the story)

Situation #2
Imagine you are writing to a friend in the year 2000. "It seems ages ago that we were in school. So much has happened since then." (Go on to explain)

Evaluation Idea

Have the students read their stories to the class and discuss the impacts that energy has on future lifestyles.

Heat Energy

Activity
24

	Future	Grades	Time
Science, Art, Language Arts	?	**4-6**	**3x45 min.**

Concept

New energy resource technologies are continually being developed.

Activity Goal

The students will list possibilities of recycling heat energy from electrical power plants.

What You'll Need

- Paper
- Pencils

What To Do

1. Explain to the students that a by-product of electrical generation is heat. The amount of heat generated by electrical power plants is tremendous.

2. Ask the class to do some research and list the ways we could recycle the heat energy from power plants to other areas.

Include:

A. Where will it be us[illegible]?
B. Who will use it?
C. How will it be most useful?

3. Have the students write a short report and present it to the class.

An example would be using heat energy in chicken hatcheries for increased production.

Some other possibilities to consider:

Agriculture

Energy production

Food production and preparation

House heating

Industry

Recreation

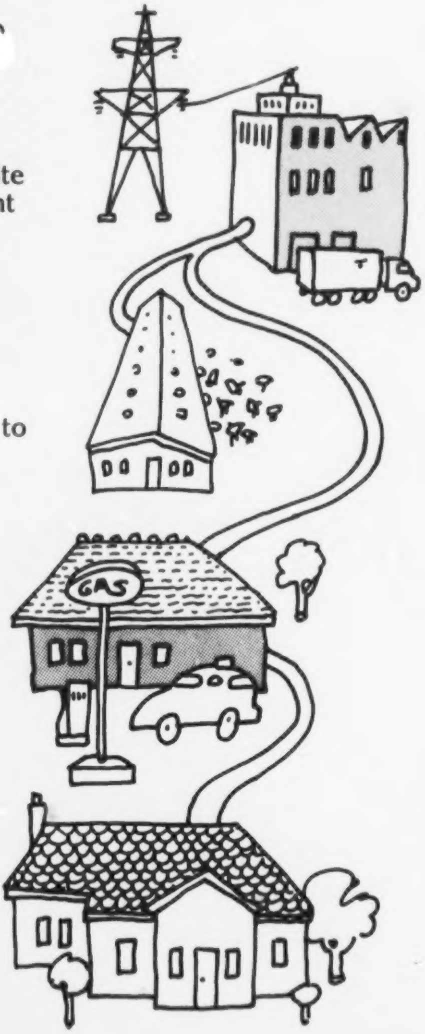
Space exploration

Transportation

Water heating

Evaluation Idea

Have students draw a picture of one of their ideas of using waste heat.



Be An Energy Saver!

Activity
25

	Conservation	Grades	Time
Science		**4-6**	**2x45 min.**

Concept

There are various ways to conserve energy.

Activity Goal

Students will identify ways they can conserve energy at home.

What You'll Need

- Hot plate
- Saucepan (one with a lid)
- Liquid measuring cup
- Watch
- Water
- Paper
- Crayons
- Copy of "Energy Saving Tips" work sheet for each student

What To Do

1. Ask students if they think there would be any difference between boiling water in a covered pan and boiling water in a pan without a lid. Why or why not? What differences might there be? List their responses on the chalkboard. Examples: faster boiling with lid; hotter water with lid; more evaporation without a lid.

2. Teacher demonstration:

A. Turn on hot plate. Add two cups of water to a saucepan. Do not use a lid. Once the hot plate is hot, put the saucepan on it. Have students time how long it takes for the water to boil vigorously. Record the time it takes.

B. Allow the saucepan to cool. Add two cups of water to the saucepan and cover the pan with a lid. Put the saucepan on the hot plate once it is hot. Have students time how long it takes for the water to boil vigorously. Record the time it takes.

3. Ask: Did covering the pan save energy? Why?

4. Ask students to think of other ways to save energy and make a list on the chalkboard. Using "Energy Saving Tips," discuss with students how these practices help conserve energy and how they can help conserve energy in their homes.

Evaluation Idea

Have the students list all the ways they use energy while getting ready for school in the morning. Then have them list ways they can conserve energy while getting ready for school.

ENERGY SAVING TIPS

Name ______________________________

Date ______________________________

_____ Take quick showers rather than tub baths.

_____ Turn off lights in unoccupied rooms

_____ Turn off the TV when no one is watching it.

_____ Open the refrigerator and freezer as little as possible, and only for a short period of time.

_____ Walk, car pool, or take the bus to school, if possible.

_____ Use a sink stopper or dish pan rather than washing and rinsing, dishes under running water.

_____ Use the dishwasher only when fully loaded.

_____ Avoid opening the oven door while cooking.

_____ Make sure water faucets don't drip.

_____ Boil water in covered pan. Match the size of the pan to the heating element.

_____ Wash clothes in warm water or cold water; rinse in cold.

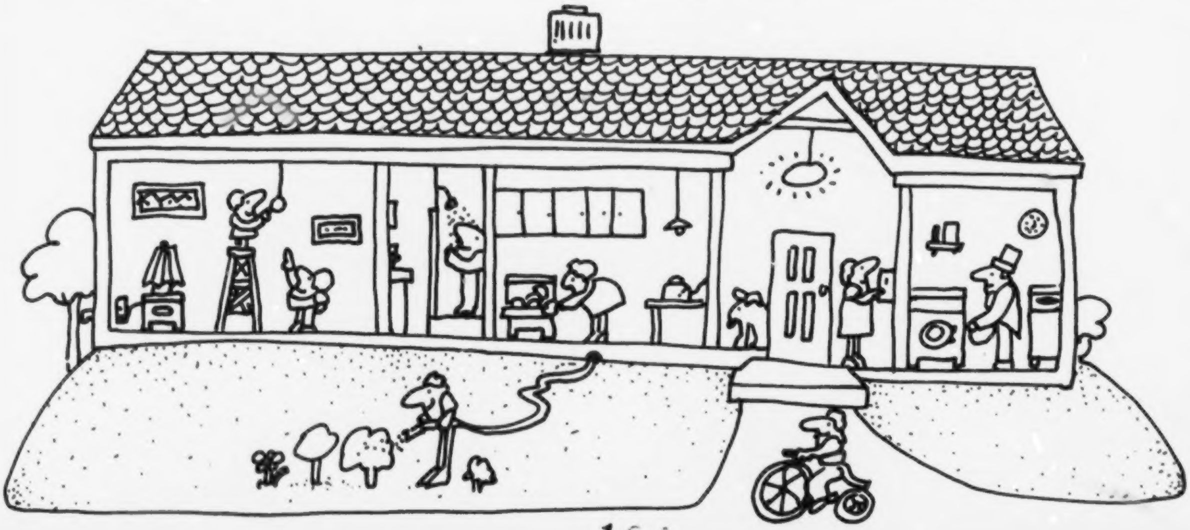
_____ Walk or ride a bicycle, rather than drive the car, whenever possible.

_____ In the winter, set the thermostat at 68 degrees. If the thermostat controls the air conditioning, in the summer set the thermostat at 78 degrees.

_____ Close the chimney damper when the fireplace is not being used.

_____ In the winter, keep draperies and shades open in sunny windows; close them at night. In the summer, close curtains when the sun is shining directly in the windows

_____ Install storm windows and doors.



Watts the Difference

Activity
26

	Conservation	Grades	Time
Science, Mathematics		**4-6**	**60 min.**

Concept

There are various ways to conserve energy.

Activity Goal

The students will compare durability and lifetime of various types of bulbs and will predict which will last the longest.

What You'll Need

- "Light Bulb Survey" for each student

What To Do

1. Discuss with students how a light bulb works and the parts of a light bulb. A light bulb converts electrical energy into heat and light energy. The conversion is due to the resistance of the filament to the electric current (electricity). You may want to make an overhead transparency of the enclosed light bulb diagram.

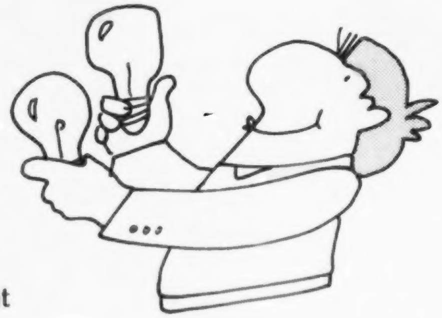
2. Have the students examine several different types of light bulbs, including the light bulb packages. Have them decide which are most efficient in relationship to lifetime, wattage, and amount of light produced. Explain that lumen is a measure of light equivalent to a certain number of lighted candles.

Remind them that a watt is a unit of electrical power, and that electricity is used in kilowatt-hours (kWh). A kilowatt-hour is the number of kilowatts (1,000 watts) used per hour.

3. Distribute a "Light Bulb Survey" to each student and have them survey the types of bulbs found in their homes, recording the information for wattage, lumens, and lifetime for each type of bulb. You may even want students to survey the light bulbs sold in a store.

4. Have each student calculate the electricity used in kWh by each type of light bulb in its lifetime:

$$\text{kWh} = \text{hours of life x } \frac{\text{wattage}}{1000}$$



You may wish to have students calculate the cost for operating each light bulb for its life. You can obtain your electric rate from your local utility. To determine the cost, simply multiply the rate by the total kWh.

5. Ask the students to share their information and decide which bulb may be more efficient considering time, illumination (lumens), and wattage. Ask them how the type of light bulb used would affect the conservation of electricity.

6. Have the students construct graphs to represent the relationship between wattage and illumination; the kWh consumed in its life and the lifetime cost of operation.

Evaluation Idea

1. A lumen is:
   - (A) The amount of electricity used by a light bulb
   - (B) The rate at which electricity is calculate
   - (C) The amount of light produced by a light bulb
   - (D) All of the above

2. A watt is:
   - (A) The amount of electricity used by a light bulb
   - (B) A unit of electrical power
   - (C) 1/1000 of a kilowatt
   - (D) All of the above

3. If you use a 75 watt light bulb for 5 hours, how many kilowatt-hours (kWh) of electricity did you use?
   - (A) .375 kWh
   - (B) 375 kWh
   - (C) 3.75 kWh
   - (D) 37.5 kWh

4. The light bulb converts electricity into light through:
   - (A) A fuse
   - (B) Resistance
   - (C) Pressure
   - (D) None of the above

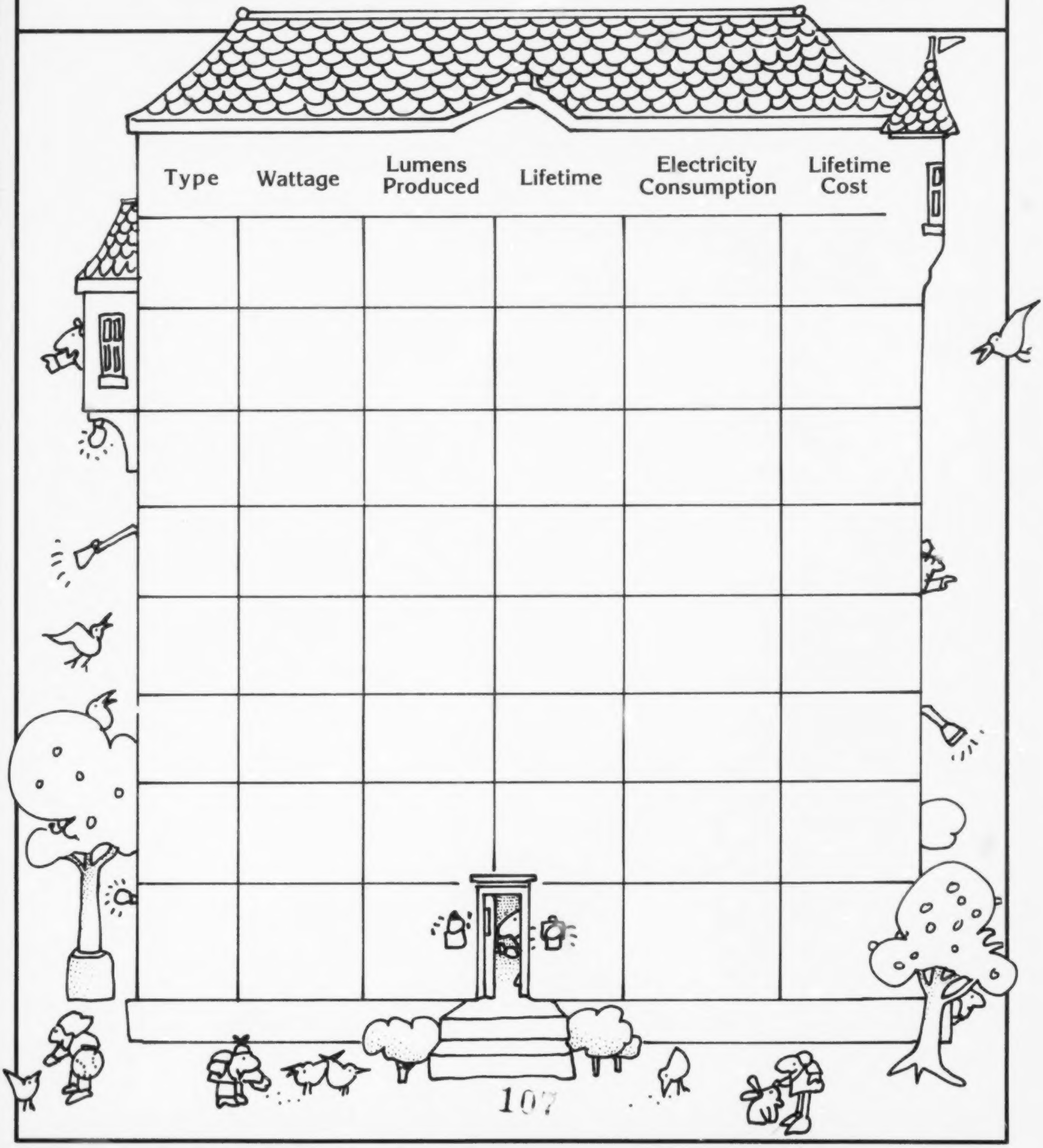
Answers

1-C, 2-D, 3-A, 4-B

LIGHT BULB SURVEY

Name ______________________________

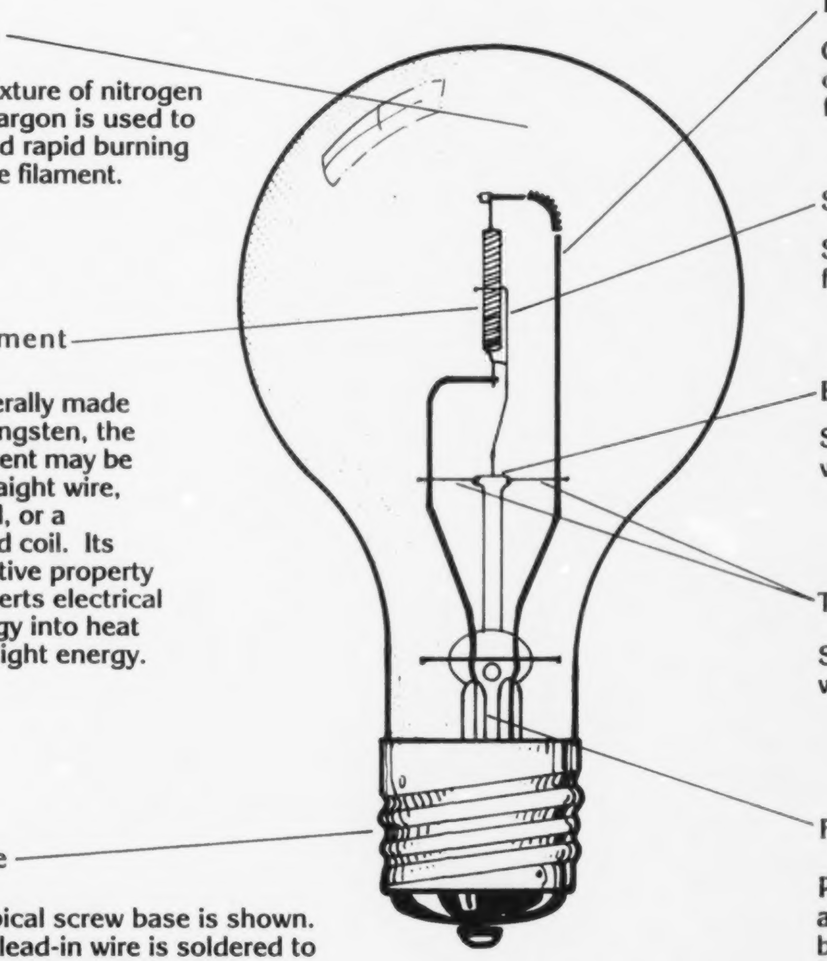
Date ______________________________



Type	Wattage	Lumens Produced	Lifetime	Electricity Consumption	Lifetime Cost

Typical Incandescent Light Bulb

Soft glass is generally used. Hard glass is used for some lamps to withstand higher bulb temperatures and for added protection against bulb breakage due to moisture. Bulbs are made in various shapes and finishes.



Gas

A mixture of nitrogen and argon is used to retard rapid burning of the filament.

Filament

Generally made of tungsten, the filament may be a straight wire, a coil, or a coiled coil. Its resistive property converts electrical energy into heat and light energy.

Base

A typical screw base is shown. One lead-in wire is soldered to the upper rim of the base. The base allows electric current to flow through the light bulb.

Lead-in Wires

Carry the electric current to and from the filament.

Support Wires

Support the filament.

Button

Supports tie wires.

Tie Wires

Support lead-in wires.

Fuse

Protects the lamp and circuit by blowing if the filament arcs.

Energy Haiku

Activity
27

Language Arts, Science, Art	Conservation	Grades	Time
		4-6	30 min.

Concept

There are various ways to conserve energy.

Activity Goal

The students will write Haiku poetry about using our energy resources in an efficient manner.

What You'll Need

- Examples of Haiku from a language arts textbook
- Word list
- Paper for each student
- A pencil for each student

What To Do

1. The pattern of a Haiku poem consists of three lines. The first has five syllables, the second line seven, and the third line five. Read several examples of Haiku to the class.

Oil
Deep within the earth.
Increased usage daily now.
Awareness...long life?

2. Discuss with the students the 5-7-5 form of Haiku.

3. Tell the students you would like them to write a Haiku poem with an energy conservation theme.

4. Distribute the list of energy-related terms and discuss them with the class. The students may choose words from this list to include in their poem.

5. Write one poem as a class. Choose a word from the list. Write this as a title, then work through the lines, reminding the students of the 5-7-5 pattern.

6. Have students create a water color illustration of their Haiku poems.

Optional Activity

As an art activity, have the students write their Haiku on rice paper. Encourage them to illustrate the poem around its edges. Once all poems are written sit on the floor in a circle and listen to each other reading Haiku.

Career Awareness Idea

Invite a poet to visit the class to discuss poetry and his/her occupation and style.

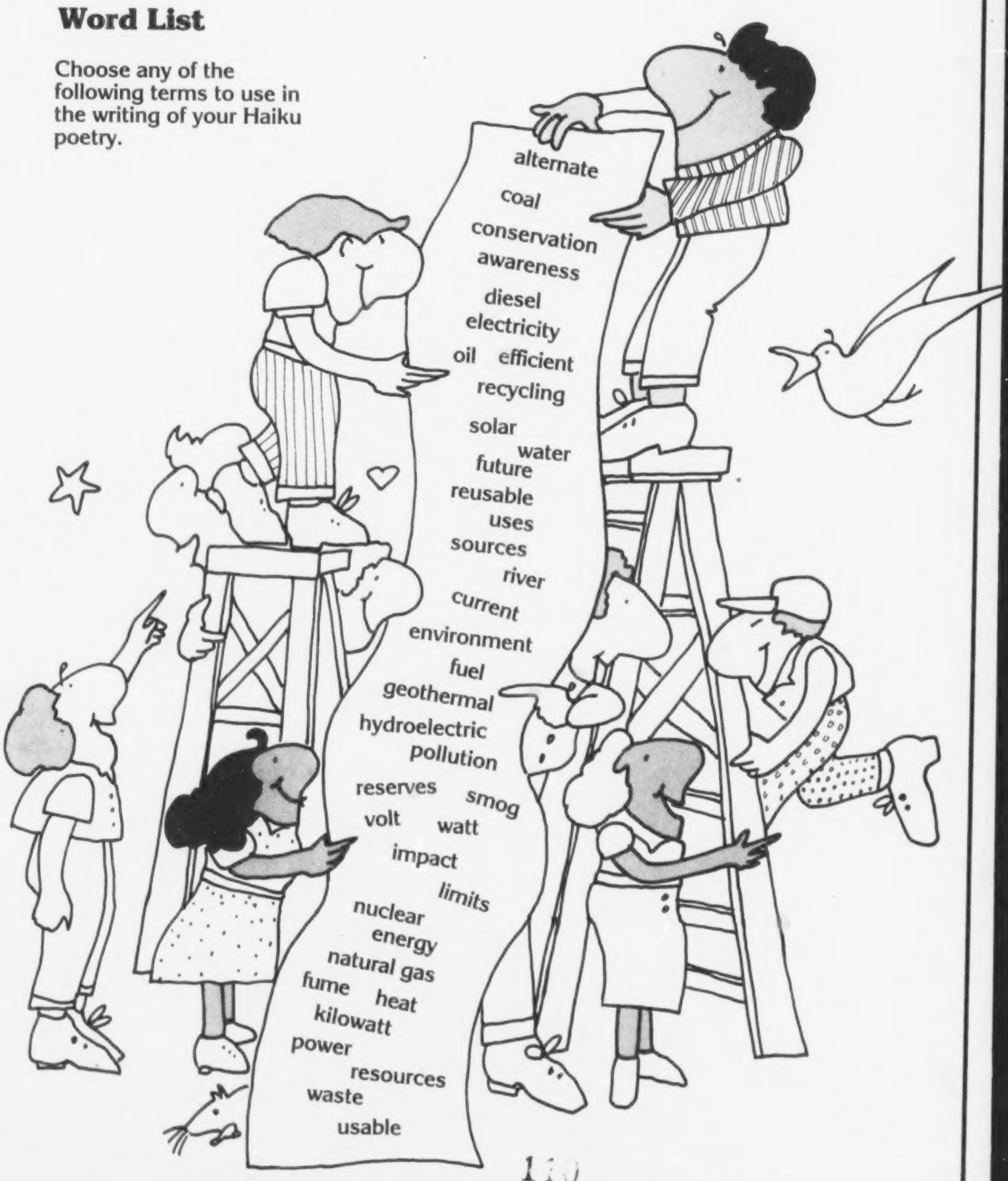
Evaluation Idea

Ask students to explain the meaning of their poems.

ENERGY
HAIKU

Word List

Choose any of the following terms to use in the writing of your Haiku poetry.



alternate
coal
conservation
awareness
diesel
electricity
oil efficient
recycling
solar
water
future
reusable
uses
sources
river
current
environment
fuel
geothermal
hydroelectric
pollution
reserves smog
volt watt
impact
limits
nuclear
energy
natural gas
fume heat
kilowatt
power
resources
waste
usable

Controlling Consumption

Activity
28

Science, Mathematics, Social Studies	Conservation	Grades	Time
		4-6	45 min.

Concept

The implementation of energy conservation practices is affected by social and political decisions.

Activity Goal

The students will analyze the effects of conservation, as compared to unlimited consumption, on the life expectancy of energy resources.

What You'll Need

- Two cookies for each student
- Clock or timing device
- One napkin for each student

What To Do

1. Give each student a cookie and napkin.

2. When the signal is given have students begin eating their cookies. Have them stand when they have finished eating their cookies. Count the students who have finished every 15 seconds until all cookies are consumed. Once a student stands, he/she must keep standing until all students are finished.

3. Create a line graph for the data, students standing versus time. You may wish to have students create the graph.

4. Distribute a second cookie. This time students can only take a bite when you say "take a bite" (every 15 seconds). The system is the same--students stand when finished and you tally the standing students every 15 seconds.

5. Again construct a line graph.

6. Compare the graphs: Graph One represents unlimited consumption while Graph Two represents conservation. Is Graph Two like Graph One? How are they different? How long did it take for all resources to be eliminated?

7. Discuss the term "conservation." In the second exercise, conservation was practiced. Does conservation result in preservation? Why not? What good does it do to conserve? What happens to the life expectancy of the energy resource under conservation?

8. Discuss with the students the following questions:

A. How was the rate of consumption controlled in the second cookie?

B. Can we control how rapidly we use resources?

C. Does this have any implications for the use of coal, natural gas, oil, electricity? If so, what?

9. Discuss with students why and how people conserve energy. Use the following as examples: 55 mph speed limit, thermostats lowered to 68 F, daylight savings time, taxes (gasoline tax), etc. This option can be expanded and enhanced by having students research the social, political, and economic aspects of energy conservation.

Evaluation Idea

True or False:

1. Energy conservation increases the total amount of energy available.

2. Conservation can be a form of regulation.

3. Economics (cost of goods/services) causes individuals to reduce their use...conserve.

4. Conservation increases the life expectancy of the energy resource.

Answers

1-F, 2-T, 3-T, 4-T

Energy Saving Survey

Activity
29

Science, Social Studies	Conservation	Grades 4-6	Time 2x30 min.

Concept

Energy conservation practices affect lifestyles, quality of life, and standard of living.

Activity Goal

The students will identify energy conservation practices and conduct a survey to learn more about energy conservation habits of others.

What You'll Need

- "Energy Saving Survey" work sheet for each student

What To Do

1. Discuss with the students that most human activities use energy. Some activities require more energy than others. In addition to the energy necessary to run our bodies, we use other forms of energy to accomplish tasks, such as electricity.

2. Have the students define energy conservation. List on the chalkboard several examples of ways energy can be conserved.

3. Explain that the choices we make regarding energy use can affect our lifestyles and our resources. There are many reasons for the choices we make. For example, sometimes our choices are due to habit, convenience, and/or necessity.

4. Give each student the handout, "Energy Saving Survey." Discuss with the students each question on the survey sheet. Have the students survey five adults and bring their completed work sheet to class the next day.

5. Compare the answers among the class. It might be helpful to use a graph to compare their answers.

6. Discuss the importance of everyone helping to conserve energy!

Evaluation Idea

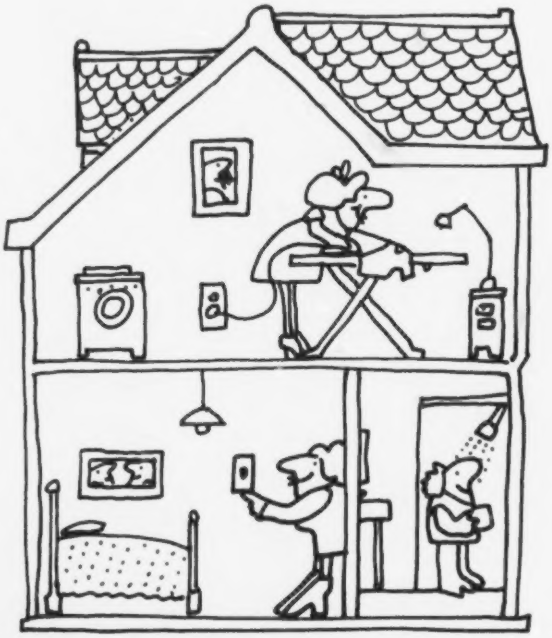
Have the students keep a list of ways they conserved energy for one day.

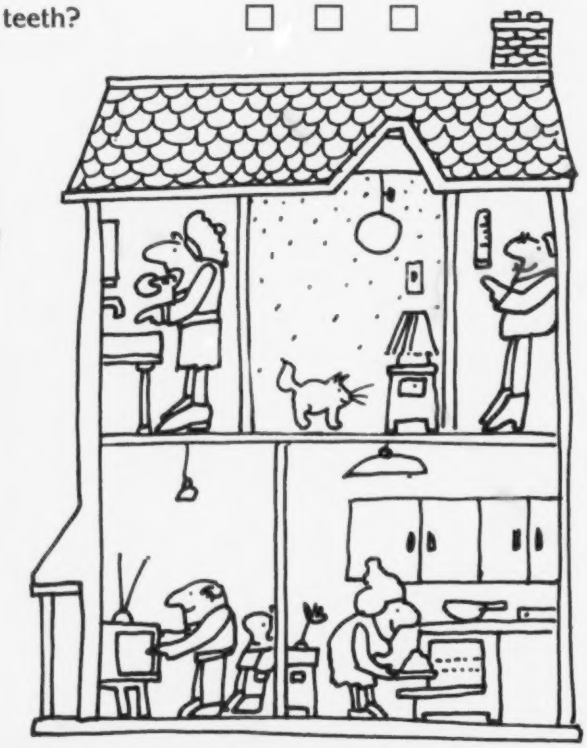
ENERGY SAVING SURVEY

Name ____________________

Date ____________________

DO YOU:	YES	NO	SOMETIMES
1. Take a quick shower instead of a bath?	☐	☐	☐
2. Turn off lights in unoccupied rooms?	☐	☐	☐
3. Open the oven door while baking?	☐	☐	☐
4. Have storm windows?	☐	☐	☐
5. Turn off the TV when no one is watching it?	☐	☐	☐
6. Keep the thermostat at 68 in the winter?	☐	☐	☐
7. Take a bus instead of driving?	☐	☐	☐
8. Iron once a week instead of everyday?	☐	☐	☐
9. Use the dishwasher only when fully loaded?	☐	☐	☐
10. Turn the water off while brushing your teeth?	☐	☐	☐





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How Much TV Do You Watch?

Activity 30

Mathematics, Science, Social Studies	Conservation	Grades **4-6**	Time **4x30 min.**

Concept

Energy conservation practices affect lifestyles, quality of life, and standard of living.

Activity Goal

The students will understand the cost of using the TV.

What You'll Need

- "How Much TV Do You Watch?" work sheet for each student

What To Do

1. Explain to the students what a watt, kilowatt, and kilowatt-hour are.

A. Watt: A metric unit of power used to measure electricity--the rate at which work is done or energy (electricity) used.

B. Kilowatt: A metric unit of power equal to 1,000 watts.

C. Kilowatt-hour (kWh): The amount of energy (electricity) used in kilowatts per hour. 1 kWh = 1kW used per hour or 1,000 watts used per hour.

2. Explain that electric utilities charge people for the number of kWh they use per month. The rate is multiplied by the kWh used plus taxes to determine your monthly electric bill.

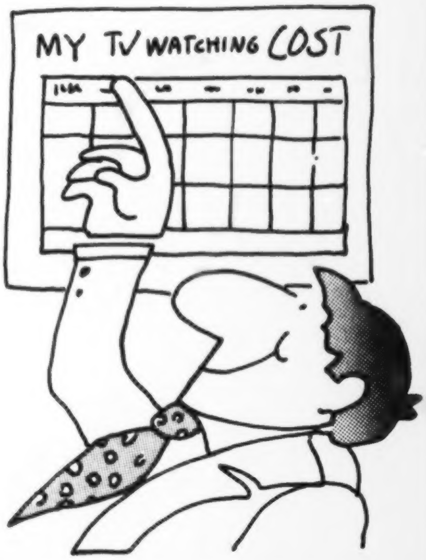
3. Inform students that they are going to conduct a scientific experiment. The experiment is to determine how much electricity they use watching TV and what it costs for one week.

A. Have the students keep a record of how long they watch television each day for one week. Start on a Monday and end on the following Sunday night.

B. At the end of the week, have each student construct either a line graph or bar graph illustrating their results (data). The teacher should make a graph for the entire class.

C. Now inform students that for each hour they watched TV, they used 240 watts (.24kWh) of electricity for a black and white TV and 350 watts (.35kWh) for a colored TV. Have students construct a graph illustrating the amount of electricity they used each day.

D. Now have the students determine the cost of watching TV by multiplying the kWh by the rate. Your local utility can supply you with your electric rate. You may want the students to construct a graph illustrating the cost of watching TV per day.



4. Discuss the relative merits of the programs watched, the electricity used and the cost of watching TV. Inform the students they are going to repeat the experiment, but this time they are to conserve electricity by reducing the amount of time they watch TV. Have the students repeat steps 3A through 3D.

5. Compare and discuss the results of both experiments with students. Discuss how their lifestyles, quality of life, and standard of living was changed.

Evaluation Ideas

1. If a person watches 1500 hours of TV per year, and their color TV uses 350 watts per hour, how many kilowatt-hours do they use?

2. What would it cost the person in the above problem to watch TV per year if their electricity cost them 10 cents per kilowatt-hour?

3. Construct a bar graph for the watts used by the electrical appliance below:

Iron - 1,100 watts

Refrigerator - 240 watts

Vacuum cleaner -210 watts

Range - 4,000 watts

Answers

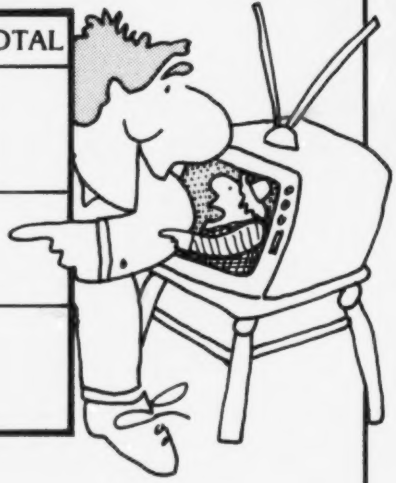
1. 525 kWh
2. $52.50

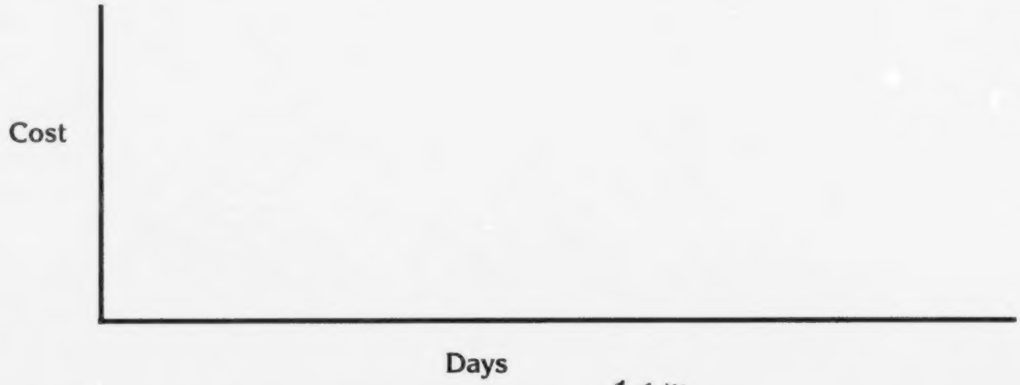
HOW MUCH TV DO YOU WATCH?

Name ____________________

Date ____________________

DAY	MON	TUES	WED	THUR	FRI	SAT	SUN	TOTAL
HOURS								
KWH								
COST								





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Keep It Cool!

Activity
31

Science, Language Arts	Conservation	Grades **4-6**	Time **2x45 min.**

Concept

Technological development affects energy conservation options.

Activity Goal

The students will understand that some technologies and activities use more energy than others.

What You'll Need

- An ice cube for each pair of students
- A variety of insulation materials (wool, cotton, foam)
- Sample containers

What To Do

1. Have each student work with a partner. Tell the class that each pair of students will receive one ice cube. They must keep the ice cubes in solid form as long as possible. The student may use any materials found in the classroom as insulation. Or you may provide students an opportunity to bring items from home. Do not allow manufactured coolers, thermos, etc.

2. Allow a few minutes for organization and collection of materials.

3. Distribute one ice cube to each pair of students and tell them that their task is to make the ice cube last as long as possible (using materials they collect as "insulation") Check the ice cubes every 10 to 15 minutes to determine how long the ice cubes last.

4. Once all the cubes are melted, the students will meet as one large group to discuss the varied materials used for insulation. The teacher will chart this information on the chalkboard. Discuss with students how insulation conserves energy, e.g., in air conditioning of homes, refrigeration, etc.

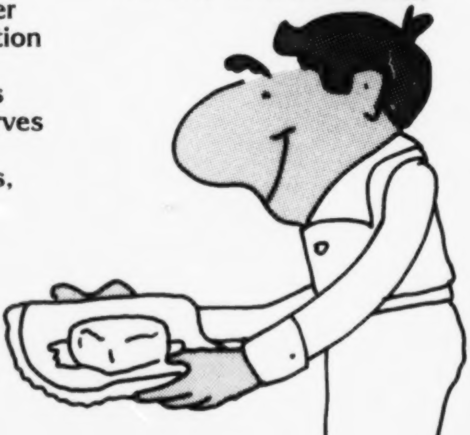
5. Have the teams write up two or three plans for insulating an ice cube. Encourage them to test the effectiveness of their plans. Have students graph how long their ice cubes lasted using the different insulation plans.

Career Awareness Idea

Have the students identify occupations created by changes in energy conservation technology.

Evaluation Idea

List three materials that could be used effectively as insulation, and describe how they conserve energy.

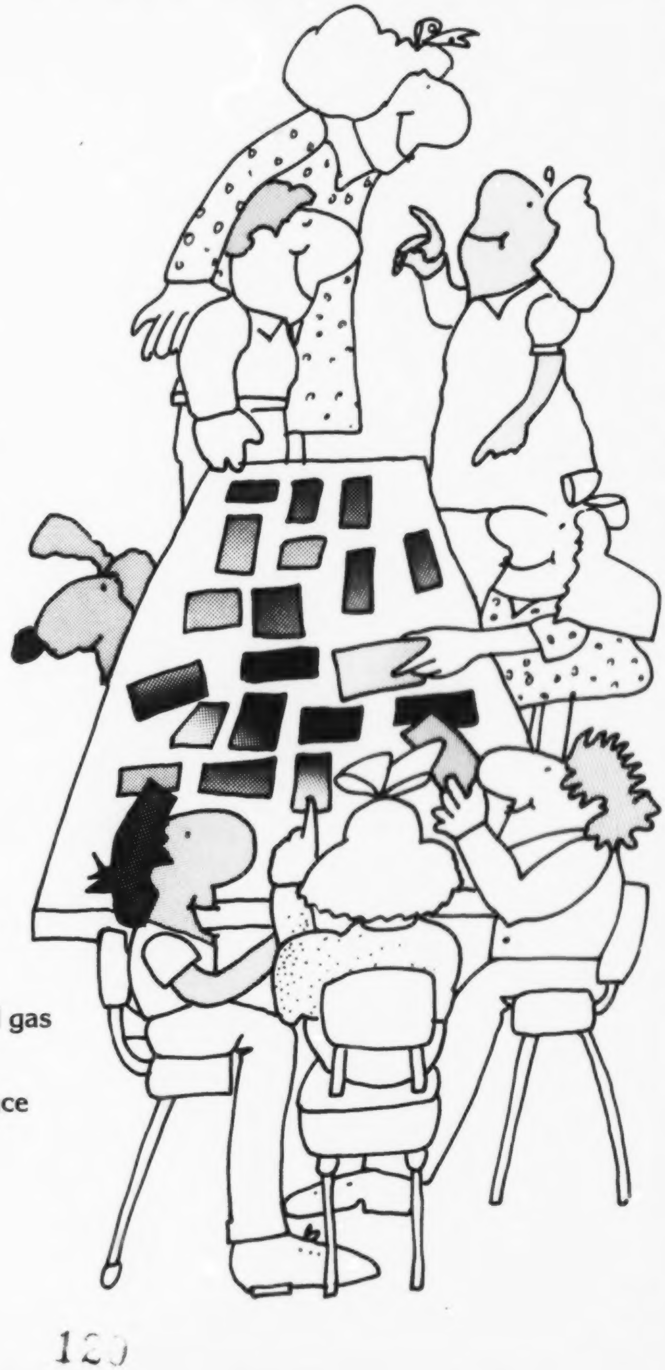


Just For Fun Activities

CONCENTRATION

Make colored cards for words being studied and colored cards for very simplified meanings for those words (one or two words for meanings if possible). See sample "Concentration Word List" below or select words students are familiar with.

To play, mix up cards and place them face down on table. Take turns choosing two cards to try to make a match (word to meaning match). The person with the most cards after all the matches have been made wins. Until meanings are somewhat firmed, the game can be played with the cards face up.



CONCENTRATION Word List

barrel
Celsius
capability
curie
cubic foot
geiger counter
REM
ton
volume
ampere
British Thermal Unit
Fahrenheit
capacity
decibel
gallon
OHM
thermometer
watt

anemometer
liquid volume
energy
temperature
maximum power
radioactivity
sound
volume of natural gas
volume
radioactive rays
electrical resistance
dose of radiation
heat
weight
power
space
wind speed
electric current

DRAWING RELAY

Arrange the students in groups of five. Have them sit on the floor or at tables in a circle at various locations in the room.

Place one pencil and some paper in the center of each circle.

Number the students in each circle from 1 to 5. Seat yourself as far away from the circles of students as you can.

When the signal is given, the first student from each circle comes to you. He/she is to come without pencil or paper. Tell each one the name of the first item on the list. (See sample list or select words students are familiar with.)

A sample list of items or objects follows:

Sun
Steam
Wood
Food
Wind

Nuclear
Coal
Hydro
Natural Gas
Geothermal

Each student returns to his/her respective circle, takes the pencil in the center and draws (without talking) the item until someone in the circle identifies it, using a soft voice. Remind students that if they yell out what is being drawn, others will hear.

The second person in the circle comes to you and tells you what the group has determined the drawing is.

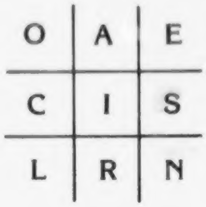
If they are correct, give that student a new object to draw. If incorrect, then return and try again.

After completing the "Drawing Relay," discuss each of the energy sources with the students, e.g., their characteristics, how each is used to provide us with energy, whether they are renewable/nonrenewable, how are they formed, etc.

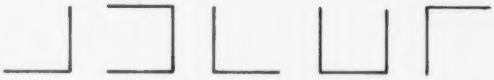
ENERGY PUZZLES

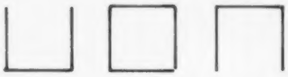
Name ____________________

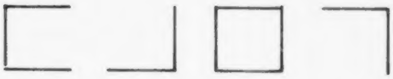
Date ____________________

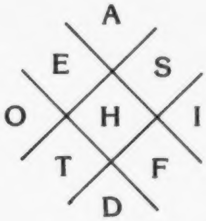


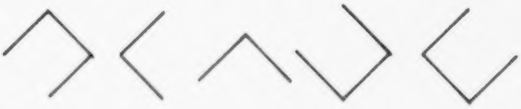
The answers to these puzzles are energy words. Match the shape of the line patterns around the letters and you will find what they are. The first letter is "O."

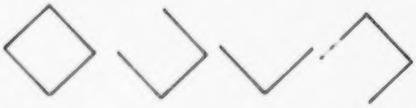
1.  ___ ___ ___ ___ ___

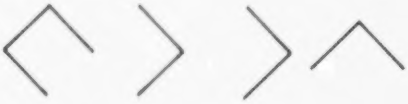
2.  ___ ___ ___

3.  ___ ___ ___ ___



4.  ___ ___ ___ ___ ___

5.  ___ ___ ___ ___

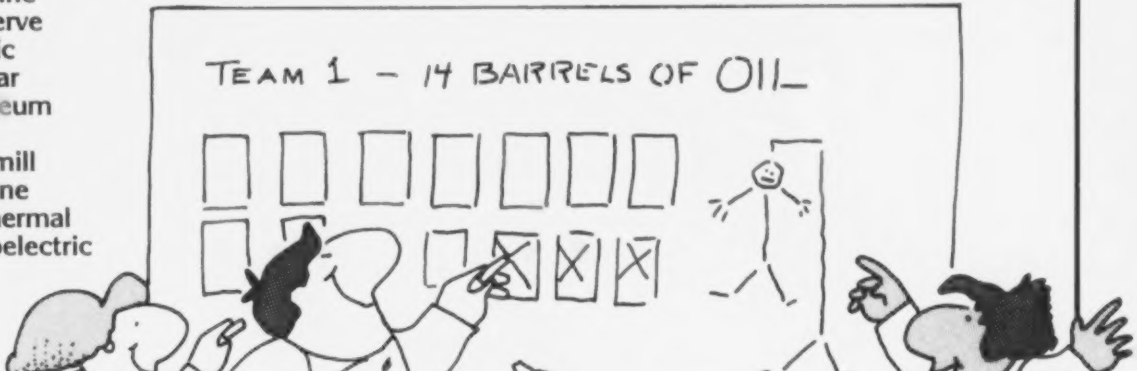
6.  ___ ___ ___ ___

Make up your own puzzle and see if a friend can figure out the answers.

ENERGY HANGMAN

This game is to be played like Hangman. Have the class decide how many barrels of oil each team has to begin the game. Each time a letter is missed, draw an "X" through the barrel of oil. When all the oil is "gone," the class is out of oil. Use the words listed below or any words in the glossary. Select one student to run the game. See how many of these energy words they get before running out of oil.

Energy
Sun
Solar
Oil
Gasoline
Conserve
Atomic
Nuclear
Petroleum
Coal
Windmill
Propane
Geothermal
Hydroelectric



FICTIONARY

This game should be played with players making up their own incorrect meanings for words from the glossary.

Two teams are needed to play this game. Team A chooses a glossary word and give the other team one correct meaning and several incorrect meanings (in random order.) Each person on Team B votes for the meaning that he/she thinks is the correct meaning. After everyone on Team B has voted, Team B receives one point for each correct answer. Then Team B chooses a word and Team A has a chance to vote for points. After an agreed-on number of turns for each team, the team with the most points wins.

Sample:

joule - metric unit of work or energy.*

joule - the nozzle opening through which gas is emitted for burning.

joule - a furnace for burning garbage or other refuse

joule - heating, ventilating, and air conditioning systems.

joule - the outer jacket of nuclear fuel elements.

joule - a shuttle that carries coal non-stop from mine to power plant.

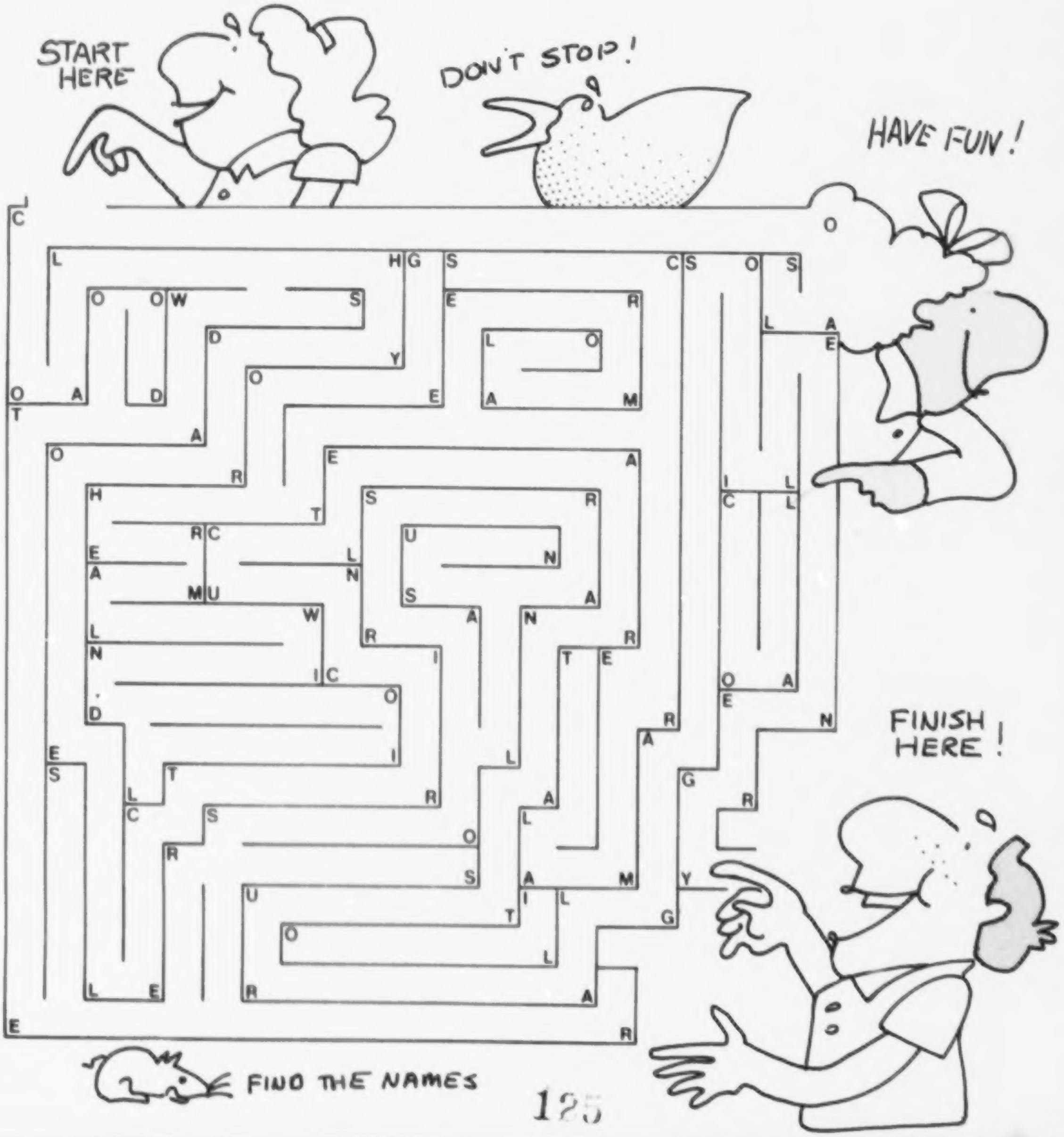
"A Joule - is a heating ventilating and air conditioning system"

FIVE PRIMARY ENERGY SOURCES

Name ____________________

Date ____________________

Find your way through the maze, and in doing so you will discover the names of the five primary energy sources. As you pass a letter, write it down on the bottom or back of this paper. When you have reached the end, look at the letters and decide what words have been spelled.

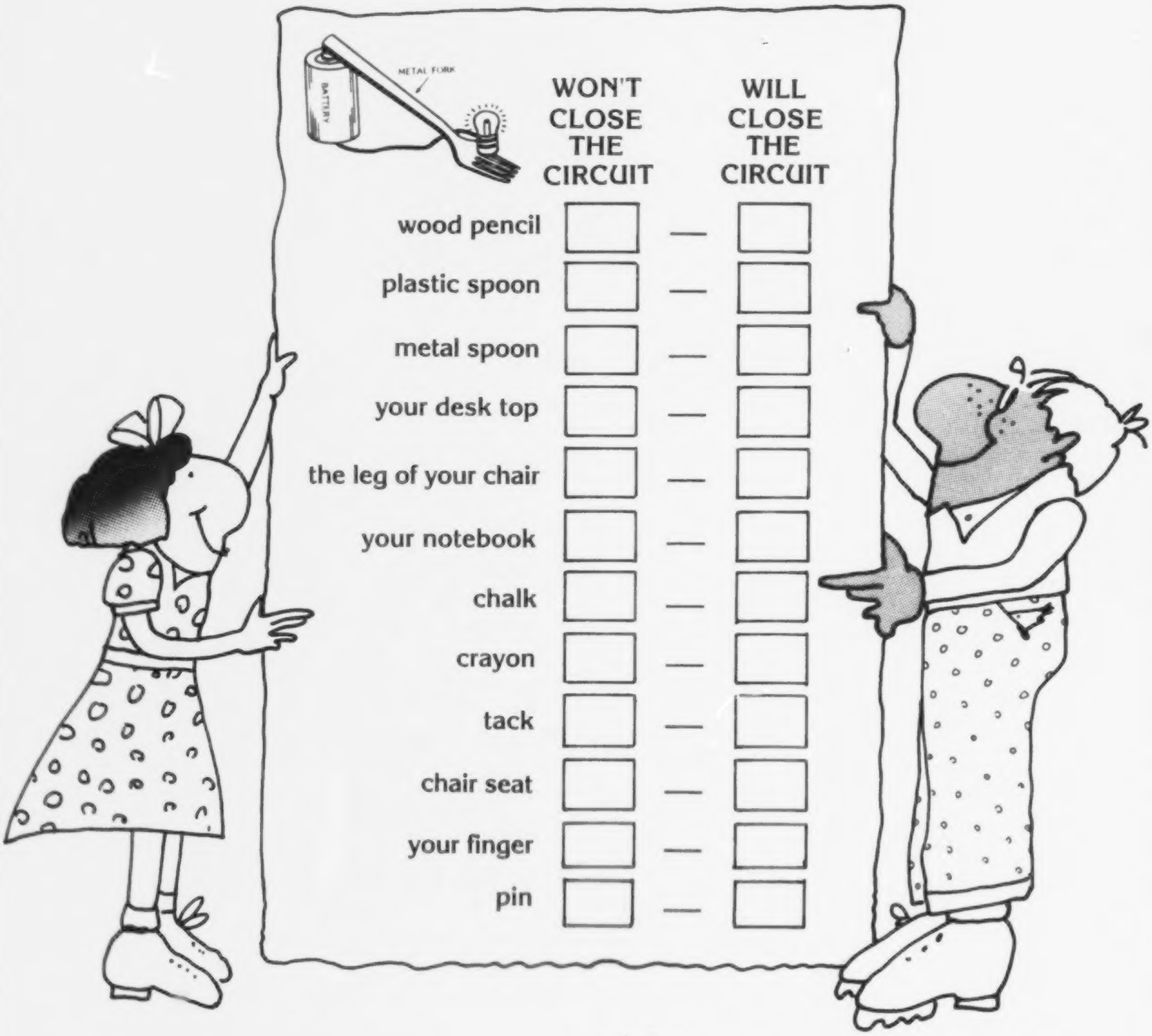

START HERE
DON'T STOP!
HAVE FUN!
FINISH HERE!
FIND THE NAMES
C
O
L H G S C S O S
O O W S E R
L A
D L O E
Y
O A D O E A M
T
A
O E A
R I L
H S R C L
T
R C U N
E L N
A
M U S A
W A N
L R R
N I T E
I C O A E
O
D R N
A
E I L
S T G
L A R
C S L R
R O
S A M Y
U I L
T G
O L
L E R A
E R

CIRCUIT CONSTRUCTION

Name ______________________

Date ______________________

Using a general purpose battery, a flashlight bulb, and a piece of insulated wire stripped at both ends, make a circuit tester. Check to see which items listed below will close the circuit and make the bulb light and which won't.



	WON'T CLOSE THE CIRCUIT		WILL CLOSE THE CIRCUIT
wood pencil	☐	—	☐
plastic spoon	☐	—	☐
metal spoon	☐	—	☐
your desk top	☐	—	☐
the leg of your chair	☐	—	☐
your notebook	☐	—	☐
chalk	☐	—	☐
crayon	☐	—	☐
tack	☐	—	☐
chair seat	☐	—	☐
your finger	☐	—	☐
pin	☐	—	☐

REBUS

Name ____________________

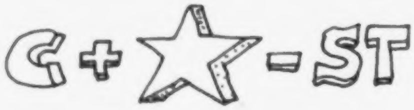
Date ____________________

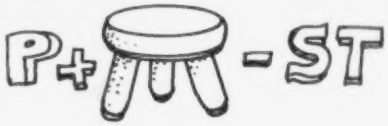
Directions: On the blank spaces, spell the words made from the picture clues. Add (+) or take away (-) to make words that tell how to conserve.

MAKE UP ONE OF YOUR OWN AND SHARE IT WITH A FRIEND.

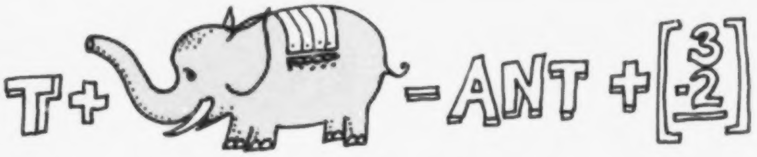
To conserve energy, I can:

1. ___ ___ ___   ___ ___ ___ ___

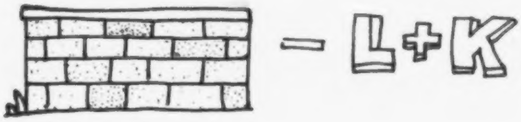




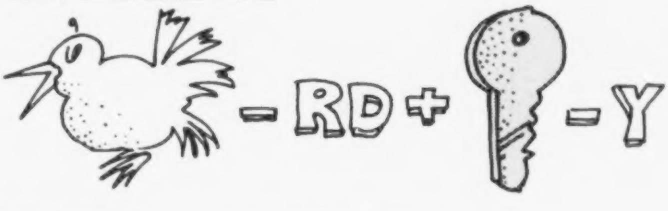
2. ___ ___ ___ ___ ___ ___ ___ ___ ___



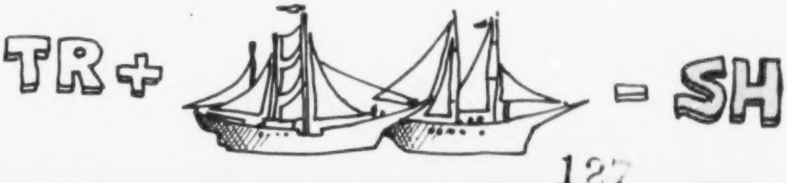
3. ___ ___ ___ ___



4. ___ ___ ___ ___



5. SHORTER ___ ___ ___ ___ ___



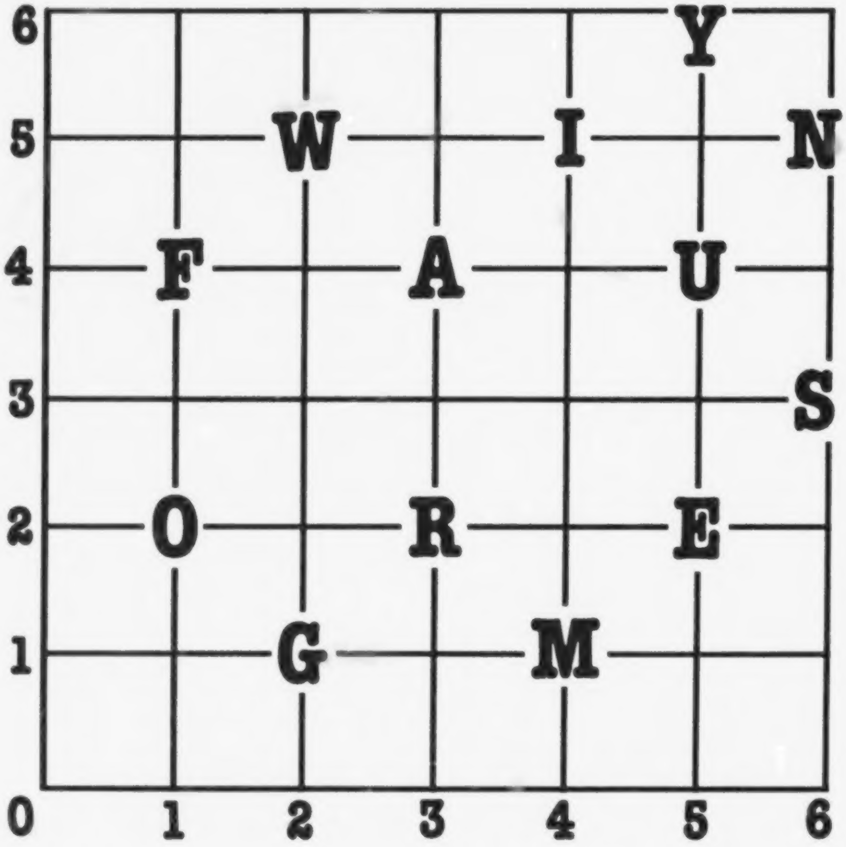
ENERGY PUZZLE

Name ____________________

Date ____________________

What are these?

BTU
Calorie
Watt
Volt
Megawatt



____ ____ ____ ____   ____ ____
(2,5) (3,4) (5,6) (6,3)   (1,2) (1,4)

____ ____ ____ ____ ____ ____ ____ ____ ____
(4,1) (5,2) (3,4) (6,3) (5,4) (3,2) (4,5) (6,5) (2,1)

____ ____ ____ ____ ____ ____
(5,2) (6,5) (5,2) (3,2) (2,1) (5,6)

Answer the energy question by solving this puzzle. To find the letter, count the boxes across first, then up. Example: Go across to two, then up to five.

The first letter is "W."
Look up the definitions of any of these energy measurement words that you don't know.

PHONETIC FUN

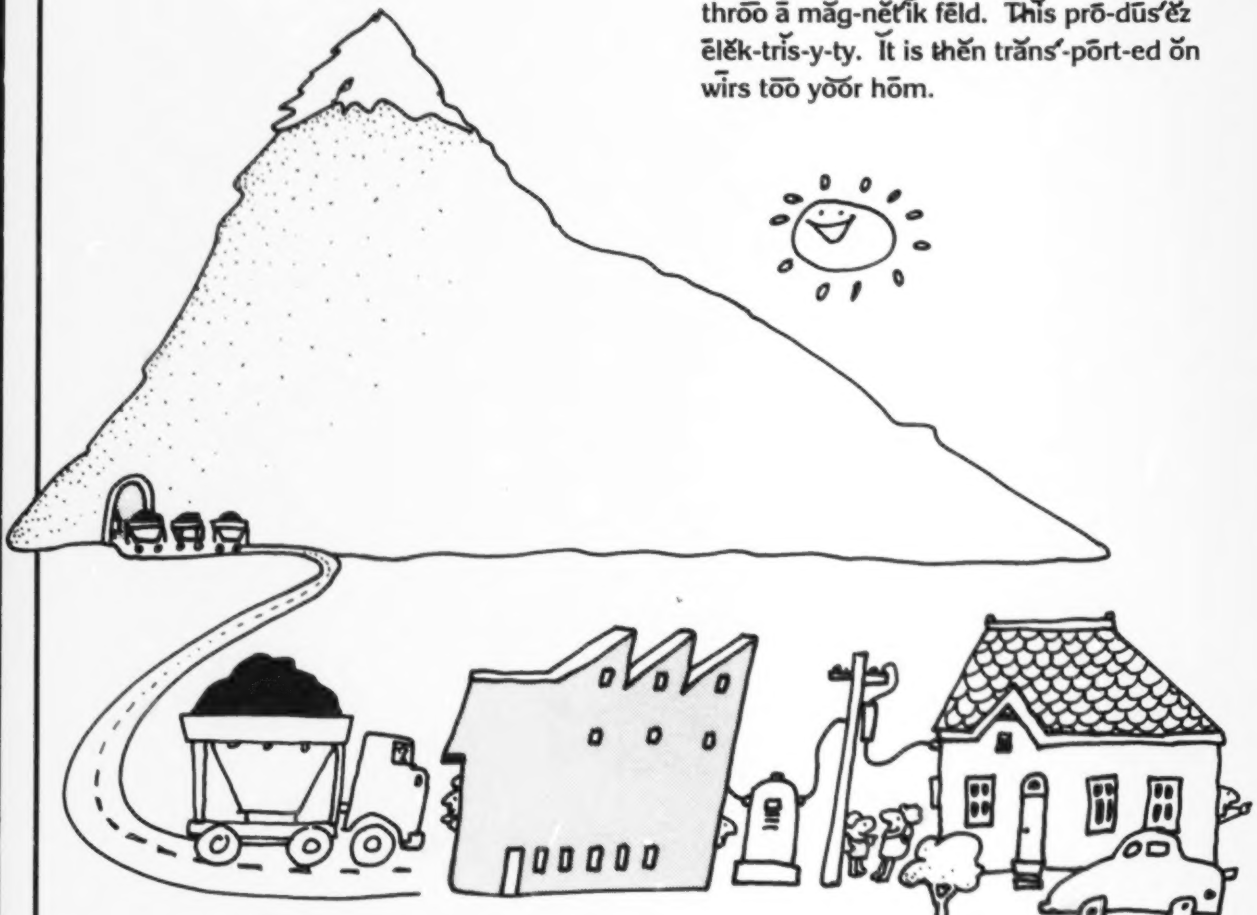
Name ________________________

Date ________________________

Rewrite the following passage. You may use your dictionary. The phonetic spelling may differ slightly depending on the publisher of your dictionary.

Kōl Frŏm thẽ Mtn To͞o Yo͝or Hōm

Kōl ĭz mīnd éthẽr bī sûr′fĭs ôr ŭn′dẽr-ground mīnĭng. Ĭt ĭz klēnd, krŭshed, ănd sôrt′ĕd. Thĕn ĭt ĭz trăns′pōrt′ĕd to͞o thẽ pou′ẽr plant. Thẽ kōl is bûrnd to͞o tûrn wô′tẽr ĭnto͞o stēm. Stēm tûrns ā tûr′bin thăt rō′tāts koils ŏv wīr ĭn ā jĕn′ẽr-ā-tor thro͞o ā măg-nĕt′ĭk fēld. Thĭs prō-dūs′ĕz ēlĕk-trĭs-y-ty. Ĭt is thĕn trăns′-pōrt-ed ŏn wīrs to͞o yo͝or hōm.



ELECTRICAL SAFETY CALENDAR CONTEST

Name ______________________

Date ______________________

As a class, create a safety calendar for use in the classroom.

Materials:

- Large paper
- Crayons or markers
- Prizes

Directions:

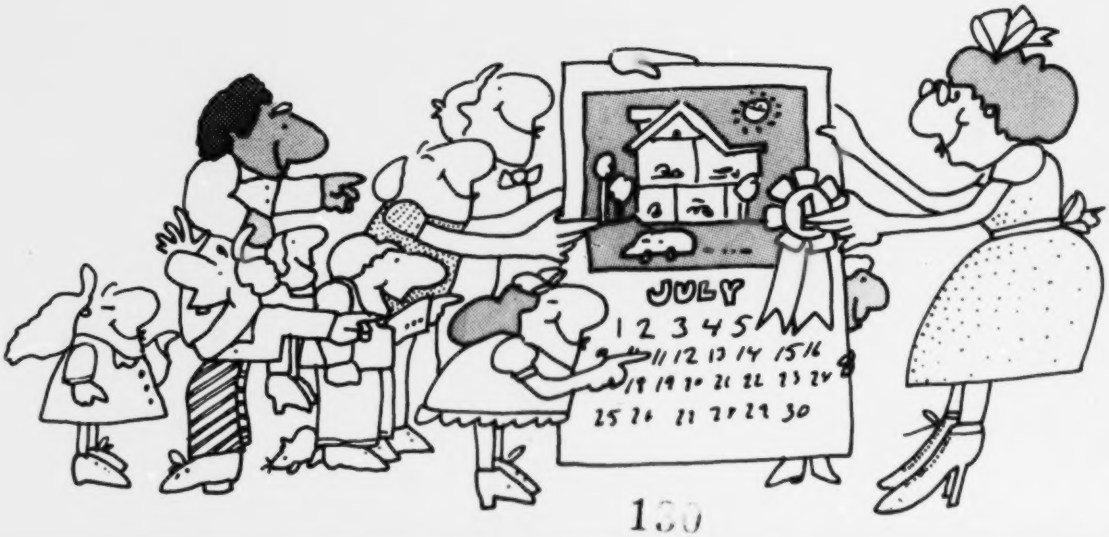
1. Divide the class into twelve groups.

2. Assign each group a specific month of the year. Instruct them to draw a picture depicting an electrical safety idea that they have learned. Where possible, use a safety tip that pertains to the month.

Example:
December - Don't overload your wall outlets with Christmas lights.
July - When swimming, don't place your plug-in radio next to the water.

3. Construct the calendar using the pictures on top and large calendar pages beneath the pictures.

4. Give prizes for the most colorful, the most detailed, the most innovative idea, etc.



Month ______________________ Date ______________

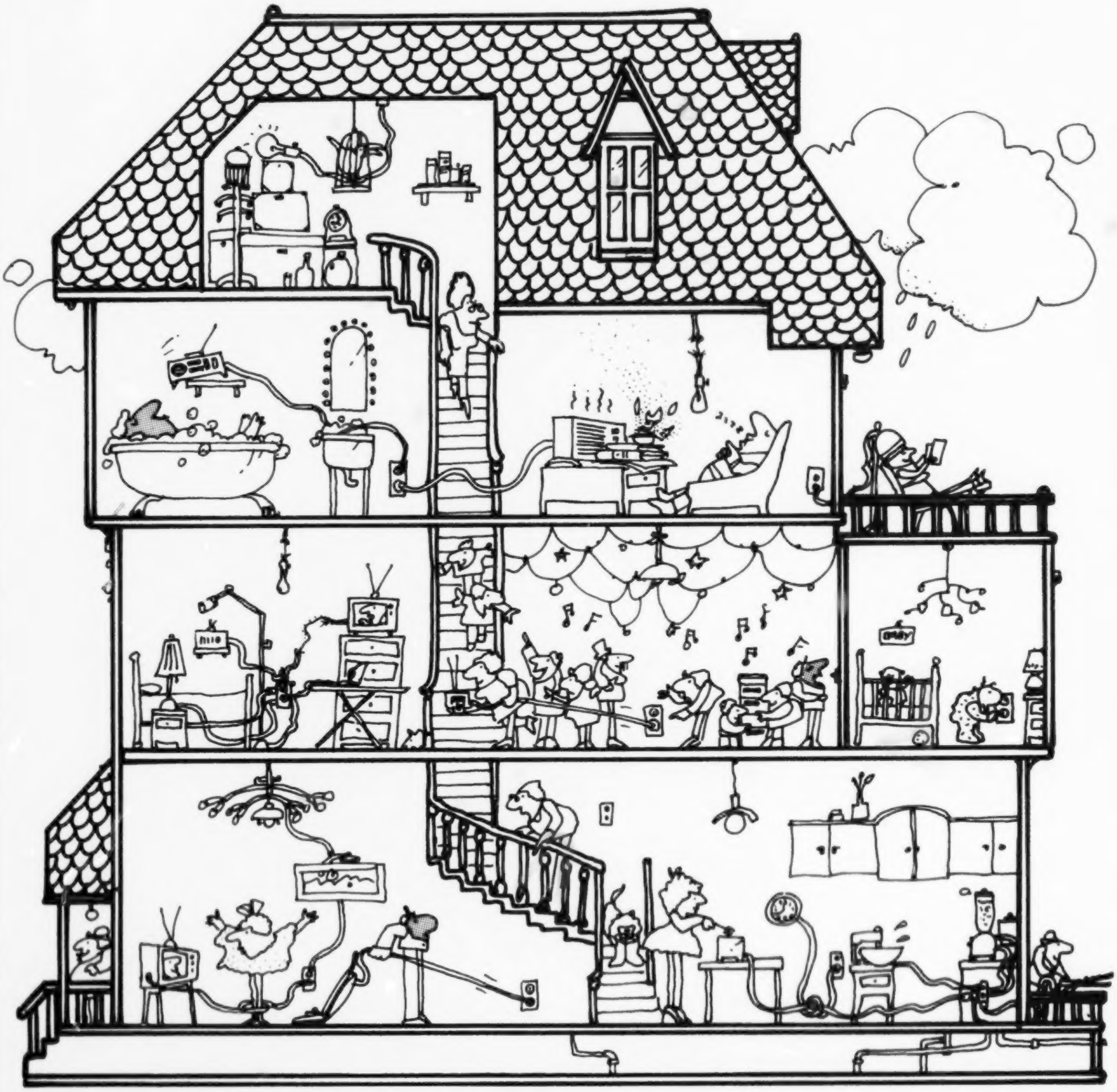
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			Safety Tip ______________________ ______________________ ______________________			

USE ELECTRICITY SAFELY

Name ______________________________

Date ______________________________

What's wrong with this picture?
Can you find 15 electrical hazards within this home?
Put an "X" on the electrical hazards you find.



BEST COPY AVAILABLE

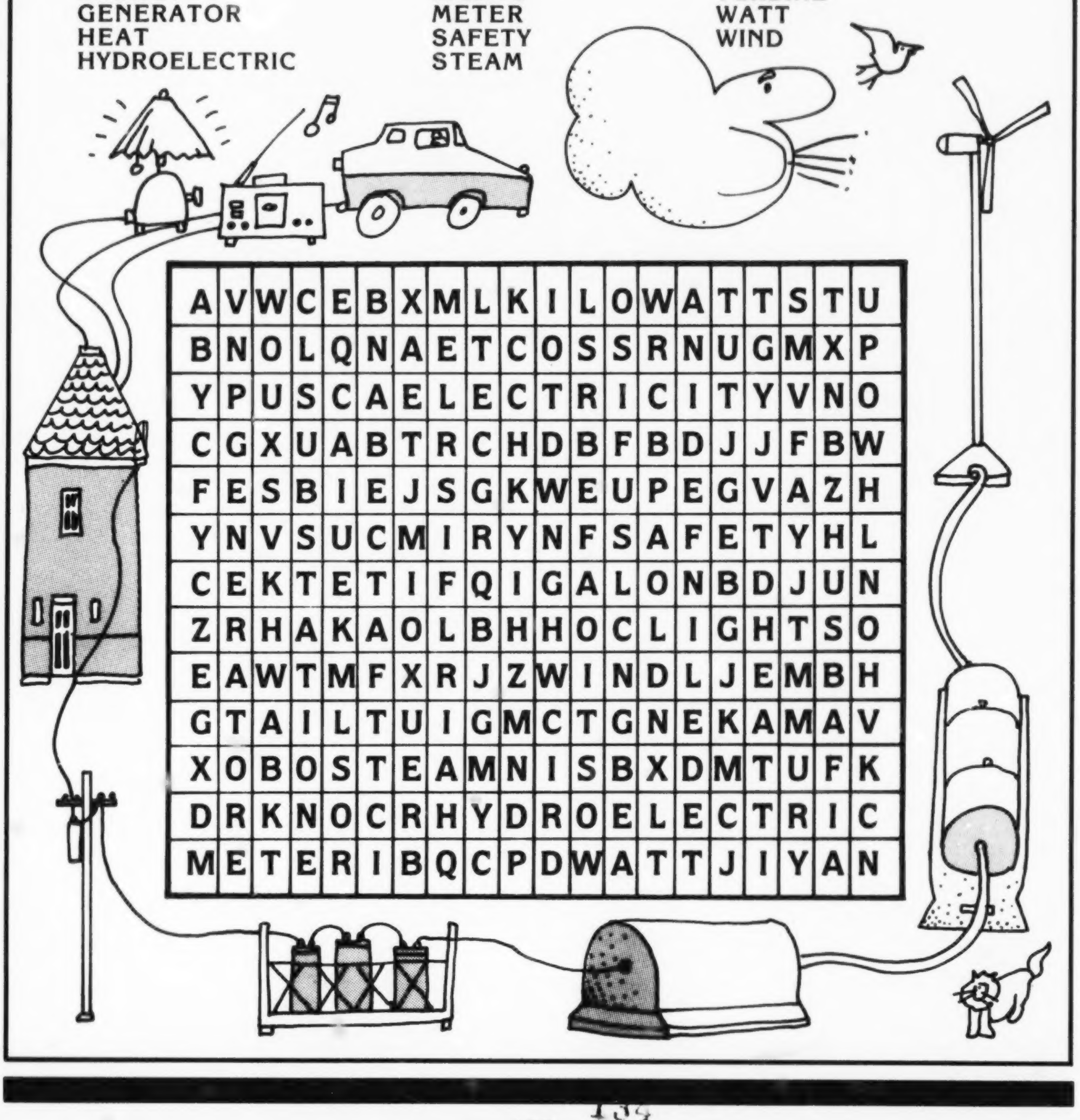
WORD SEARCH

Name ____________________

Date ____________________

Words may be read up and down, left to right, or diagonally

ELECTRICITY
ENERGY
GENERATOR
HEAT
HYDROELECTRIC
KILOWATT
LIGHTS
METER
SAFETY
STEAM
SUBSTATION
TURBINE
WATT
WIND



A	V	W	C	E	B	X	M	L	K	I	L	O	W	A	T	T	S	T	U
B	N	O	L	Q	N	A	E	T	C	O	S	S	R	N	U	G	M	X	P
Y	P	U	S	C	A	E	L	E	C	T	R	I	C	I	T	Y	V	N	O
C	G	X	U	A	B	T	R	C	H	D	B	F	B	D	J	J	F	B	W
F	E	S	B	I	E	J	S	G	K	W	E	U	P	E	G	V	A	Z	H
Y	N	V	S	U	C	M	I	R	Y	N	F	S	A	F	E	T	Y	H	L
C	E	K	T	E	T	I	F	Q	I	G	A	L	O	N	B	D	J	U	N
Z	R	H	A	K	A	O	L	B	H	H	O	C	L	I	G	H	T	S	O
E	A	W	T	M	F	X	R	J	Z	W	I	N	D	L	J	E	M	B	H
G	T	A	I	L	T	U	I	G	M	C	T	G	N	E	K	A	M	A	V
X	O	B	O	S	T	E	A	M	N	I	S	B	X	D	M	T	U	F	K
D	R	K	N	O	C	R	H	Y	D	R	O	E	L	E	C	T	R	I	C
M	E	T	E	R	I	B	Q	C	P	D	W	A	T	T	J	I	Y	A	N

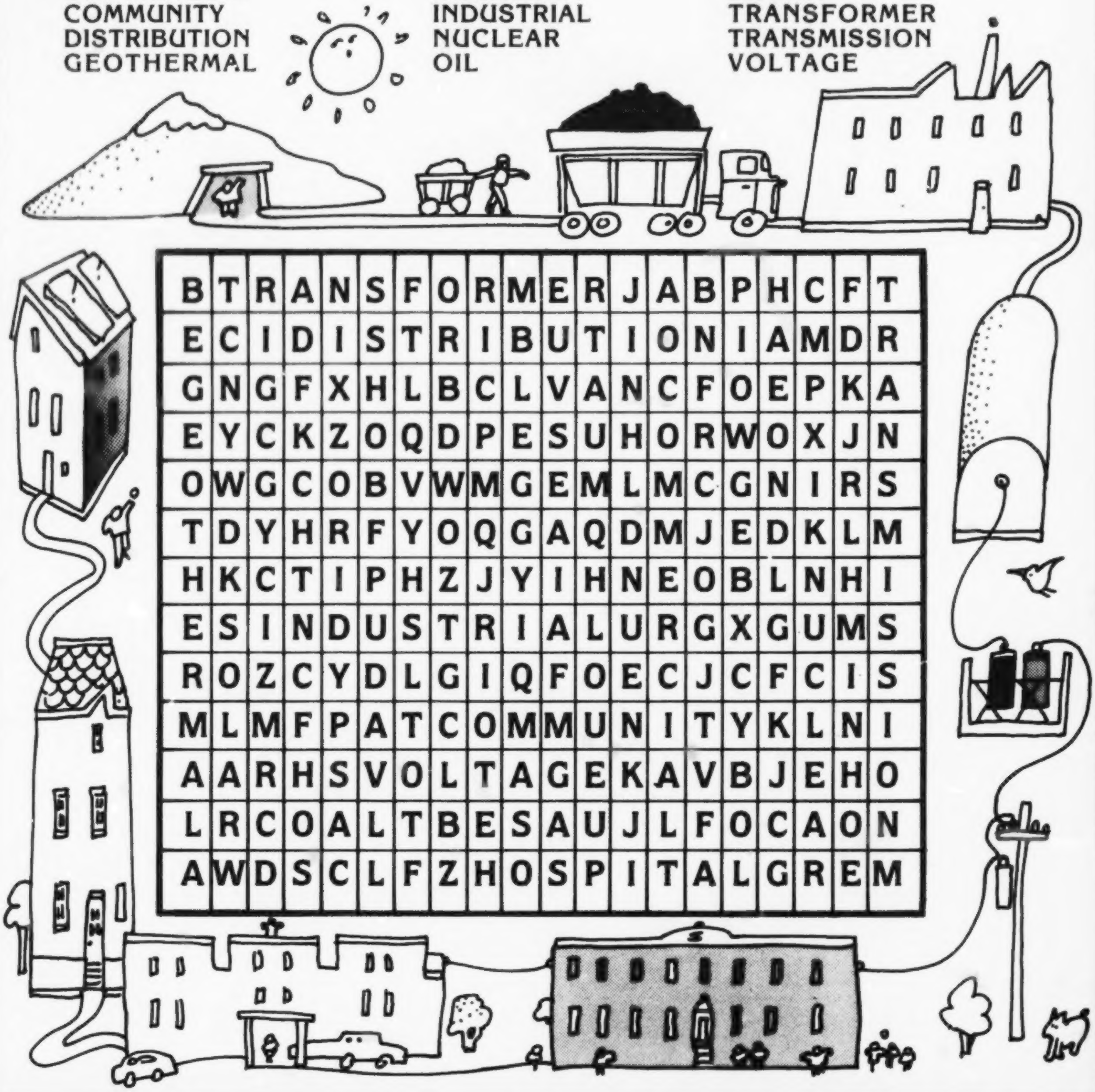
WORD SEARCH

Name ____________________

Date ____________________

Words may be read up and down, left to right, or diagonally

COAL
COMMERCIAL
COMMUNITY
DISTRIBUTION
GEOTHERMAL
HOME
HOSPITAL
INDUSTRIAL
NUCLEAR
OIL
SCHOOL
SOLAR
TRANSFORMER
TRANSMISSION
VOLTAGE



B	T	R	A	N	S	F	O	R	M	E	R	J	A	B	P	H	C	F	T
E	C	I	D	I	S	T	R	I	B	U	T	I	O	N	I	A	M	D	R
G	N	G	F	X	H	L	B	C	L	V	A	N	C	F	O	E	P	K	A
E	Y	C	K	Z	O	Q	D	P	E	S	U	H	O	R	W	O	X	J	N
O	W	G	C	O	B	V	W	M	G	E	M	L	M	C	G	N	I	R	S
T	D	Y	H	R	F	Y	O	Q	G	A	Q	D	M	J	E	D	K	L	M
H	K	C	T	I	P	H	Z	J	Y	I	H	N	E	O	B	L	N	H	I
E	S	I	N	D	U	S	T	R	I	A	L	U	R	G	X	G	U	M	S
R	O	Z	C	Y	D	L	G	I	Q	F	O	E	C	J	C	F	C	I	S
M	L	M	F	P	A	T	C	O	M	M	U	N	I	T	Y	K	L	N	I
A	A	R	H	S	V	O	L	T	A	G	E	K	A	V	B	J	E	H	O
L	R	C	O	A	L	T	B	E	S	A	U	J	L	F	O	C	A	O	N
A	W	D	S	C	L	F	Z	H	O	S	P	I	T	A	L	G	R	E	M

WORD SCRAMBLE

Name ______________________

Date ______________________

Unscramble these words then find them hidden in the picture.

SOTEATR ____________________

UCUMVA ____________________

PTOMCREU ________________

NELTEPOHE ________________

OBWL RYRED ______________

VENSITLEIO ________________

GWSENI CNAMHEI ____

EVON ________________

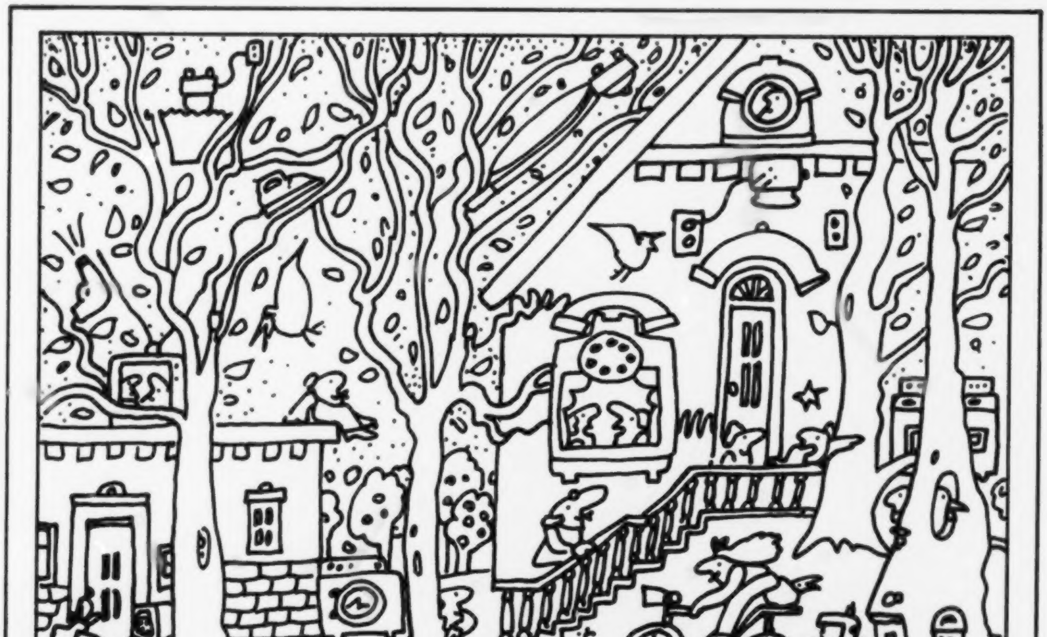
NROI ________________

DORIA ________________

KCLCO ______________

MALP ________________

HEWASR ____________

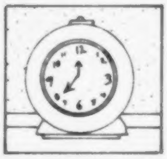


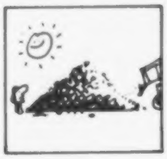
ELECTRIC MATCH UP

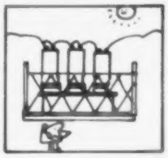
Name ______________________

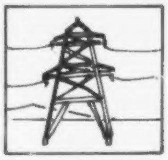
Date ______________________

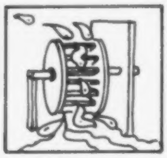
Match each picture with the correct definition.
Draw a line from the picture to the definition.

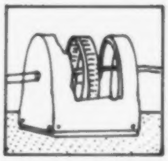


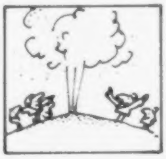


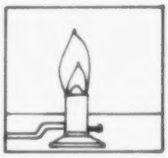


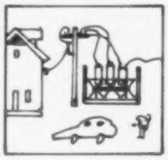


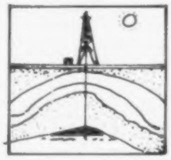


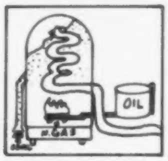


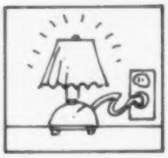












COAL: a solid black substance that burns and gives off heat. Coal was formed long ago from partly decayed vegetable matter under great pressure from the earth.

FOSSIL FUELS: coal, oil, and natural gas.

HYDROELECTRIC: electricity produced by falling water which spins a turbine-generator.

GENERATOR: a machine that produces electricity by spinning a coil of wire in the presence of a magnetic field.

TRANSMISSION: a term used by the utilities to denote high voltage electricity sent over long distances.

KILOWATT-HOUR (kWh): the amount of work delivered during the steady consumption of one kilowatt of power for a period of one hour.

SUBSTATION: a location where transmission voltage is reduced to distribution voltage.

OIL (petroleum): a liquid formed underground by the decomposition of prehistoric microscopic plants and animals.

ELECTRICITY: energy produced by the flow of electrons through a conductor, such as copper wire, which can be transformed into other forms of energy, including light, heat, sound, and mechanical.

GEOTHERMAL: energy produced by heat from deep inside the earth.

NATURAL GAS: gas formed underground by the decomposition of prehistoric microscopic plants and animals.

DISTRIBUTION: the term used by utilities to denote lower voltage electricity used in neighborhoods once it has left a substation.

STUDENT ACTIVITIES

Group activities in teaching your students about electrical energy might include the following: (Many of these activities can be easily adapted to other energy related topics.)

A. Think about these rooms in your house: the kitchen, your bedroom, the bathroom, the living room. Divide the piece of paper into four sections and list the things in each room that use electricity. Which room has the most electricity energy users? Which room has the least electricity energy users?

B. Write a story or poem about the following situation: When you woke up this morning, there wasn't any electricity. What would you do and why?

C. Have the students make as many words as they can with the letters in ELECTRICITY.

D. Involve the students in making brown bag puppets. Divide the class into small groups to give skits about electrical safety.

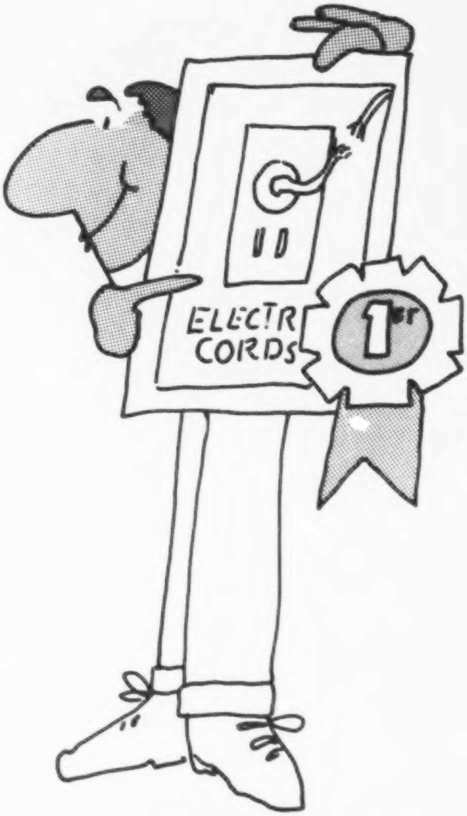
E. Blow up a balloon and tie the neck. Rub the balloon against a piece of wool, fur, or a sweater. Place the balloon against the wall. (The balloon should stick to the wall.) Now blow up another balloon and rub against a piece of wool, fur or a sweater. Place it next to the first balloon. Have the students describe what they observed. Discuss how this experiment illustrated static electricity -- because the wall has a positive charge and the balloon a negative charge, the wall attracts the balloon. Let a few students experiment with the balloons.

F. Have the students form a circle and place one student in the middle with a bean bag. The student in the middle of the circle throws the bean bag to one of the students on the outside of the circle. The student catching the bean bag must give an electrical safety tip within 10 seconds or go to the middle of the circle. Electrical safety tips cannot be repeated or the student loses and must go to the center of the circle.

ELECTRICAL SAFETY THEATER

G. Organize a class contest to write the funniest jingle or poem to remind other students what they can do to help save energy. Have the students illustrate their poems and display them where other students in the school can see them.

H. Have the students pretend they are scientists and invent a product or a solution to an energy problem. Have the students advertise their product or solution to the class.



A
PROBLEM
B
Solution
Invention

I. Organize a class contest to design posters emphasizing the importance of electrical safety. Display the winning posters so other students in the school can see them.

J. Have a contest to see which student can invent the best electrical safety device. Have the students draw a picture of their inventions and write an explanation as to what it does.

ELECTRICAL SAFETY BOARD GAME

Name ____________________

Date ____________________

Create a safety board game alone or with your class.

Materials:

- Scratch paper
- Plain white paper for the game rules and answer sheet
- Pencils
- 40 index cards
- White poster board
- Ruler
- Scissors
- Tape or glue
- Crayons or markers
- Paper clips or peanuts for playing pieces
- Box for the game cards and playing pieces
- One die or spinner

Directions:

1. Draw a rough sketch of the game board.

2. Write about 30 questions about electrical safety facts and number each question. Carefully print each question on a separate index card. Remember to include the question number.

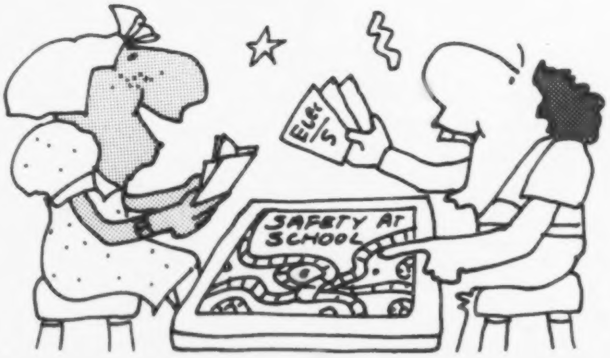
3. Make an answer sheet by listing question numbers and the correct answer beside each one.

4. Add some chance cards. For example: "Too many plugs in one outlet. Lose a turn."

5. Carefully draw the game on poster board using a ruler. Print the name of your game and color the board or add pictures.

6. Write the game rules. Include the answers for these questions:

A. What is the object of the game?
B. How many players can play?
C. Which player goes first?
D. What does that player do? Roll the die, spin the spinner, take a card, or answer a question.
E. What does the player do when a question is answered correctly? Incorrectly?
F. When is the game over?
G. Who wins?



ANSWER PAGE

Page 114

1. Ocean
2. Air
3. Soil
4. Tides
5. Heat
6. Food

Page 117

Coal
Hydroelectric
Nuclear
Natural Gas
Oil
Energy

Page 118

The items listed which will close the circuit are:

metal spoon
the leg of your chair (if it is metal)
your notebook (if you use metal rings)
tack
pin

Page 119

Car Pool
Telephone
Walk
Bike
Trips

Page 120

Ways of measuring energy

Page 121

Coal is mined either by surface or underground mining. It is cleaned, crushed, and sorted. Then it is transported to the power plant. The coal is burned to turn water into steam. Steam turns a turbine that rotates coils over in a generator through a magnetic field. This produces electricity. It is then transported on wires to your home.

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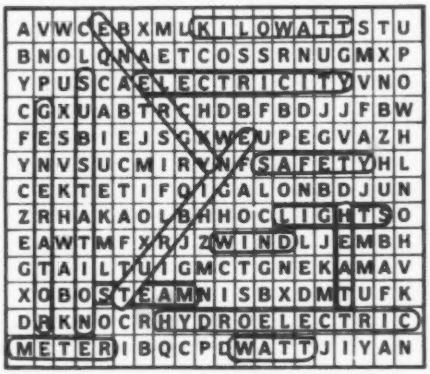

A	V	W	C	E	B	X	M	L	K	I	L	O	W	A	T	T	S	T	U
B	N	O	L	Q	N	A	E	T	C	O	S	S	R	N	U	G	M	X	P
Y	P	U	S	C	A	E	L	E	C	T	R	I	C	I	T	Y	V	N	O
C	G	X	U	A	B	T	R	C	H	D	B	F	B	D	J	J	F	B	W
F	E	S	B	I	E	J	S	G	K	W	E	U	P	E	G	V	A	Z	H
Y	N	V	S	U	C	M	I	R	Y	N	F	S	A	F	E	T	Y	H	L
C	E	K	T	E	T	I	F	O	I	G	A	L	O	N	B	D	J	U	N
Z	R	H	A	K	A	O	L	B	H	H	O	C	L	I	G	H	T	S	O
E	A	W	T	M	F	X	R	J	Z	W	I	N	D	L	J	E	M	B	H
G	T	A	I	L	T	U	I	G	M	C	T	G	N	E	K	A	M	A	V
X	O	B	O	S	T	E	A	M	N	I	S	B	X	D	M	T	U	F	K
D	R	K	N	O	C	R	H	Y	D	R	O	E	L	E	C	T	R	I	C
M	E	T	E	R	I	B	Q	C	P	D	W	A	T	T	J	I	Y	A	N

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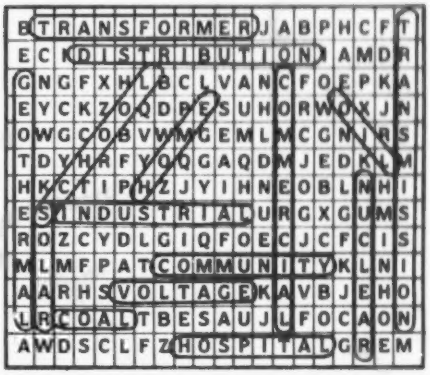

B	T	R	A	N	S	F	O	R	M	E	R	J	A	B	P	H	C	F	T
E	C	K	D	I	S	T	R	I	B	U	T	I	O	N	I	A	M	D	R
G	N	G	F	X	H	L	B	C	L	V	A	N	C	F	O	E	P	K	A
E	Y	C	K	Z	O	Q	D	R	E	S	U	H	O	R	W	O	X	J	N
O	W	G	C	O	B	V	W	M	G	E	M	L	M	C	G	N	I	R	S
T	D	Y	H	R	F	Y	O	Q	G	A	Q	D	M	J	E	D	K	L	M
H	K	C	T	I	P	H	Z	J	Y	I	H	N	E	O	B	L	N	H	I
E	S	I	N	D	U	S	T	R	I	A	L	U	R	G	X	G	U	M	S
R	O	Z	C	Y	D	L	G	I	Q	F	O	E	C	J	C	F	C	I	S
M	L	M	F	P	A	T	C	O	M	M	U	N	I	T	Y	K	L	N	I
A	A	R	H	S	V	O	L	T	A	G	E	K	A	V	B	J	E	H	O
L	R	C	O	A	L	T	B	E	S	A	U	J	L	F	O	C	A	O	N
A	W	D	S	C	L	F	Z	H	O	S	P	I	T	A	L	G	R	E	M

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Toaster Sewing Machine Vacuum Blow Dryer Lamp Washer

Radio Television Oven Clock Computer Telephone Iron

Energy Glossary

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A

Acid Rain

Any form of precipitation having a pH of less than 5.6 on a scale of 0 - 14. Pure water (pH 5.6) becomes acidic through the addition of chemicals from natural or man-made sources.

Air Pollution

The presence of contaminants in the air in concentrations that prevent the normal ability of the air to clean itself, and that interfere directly or indirectly with the health, safety or comfort of organisms, or with the full use and enjoyment of property.

Alternating Current (AC)

An electric current with its direction reversed at regular intervals. Electric current in the U.S. alternates with a frequency of 60 hertz, or cycles per second. Some European countries use 50 hertz.

Ampere

A unit of measure of electric current. One ampere equals 6.2 x 10^{18} electrons passing a point in 1 second.

Anemometer

An instrument used to determine wind speed.

Ash

The residue which remains after complete burning (or oxidation) of a combustible material.

B

Biomass

The total amount of biological material in a given area.

Boiler

Equipment which burns fuel or collects the sun's rays. Creates high temperatures to convert water to steam in order to produce electricity.

Boiling

Heated to the boiling point; the temperature at which a liquid generates bubbles and converts to vapor.

British Thermal Unit (BTU)

A common measuring unit of energy. It is the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit. One BTU equals 252 calories, 1055 joules, and 0.293 watt-hours. A cubic foot of natural gas equals about 1000 BTU's.

C

Calorie (cal.)

(1) A unit of heat energy equal to the amount of heat needed to raise the temperature of one gram of water one degree Celsius. The calorie is used when temperature is measured on the Celsius scale, while the British Thermal Unit is used when the measurement is on the Fahrenheit scale. One calorie equals 4.18 joules.

(2) An amount of food having the energy-producing value of one calorie.

Capability

The maximum load which a generator, turbine, power plant, transmission circuit, or power system can supply under specified conditions for a given time interval without exceeding approved limits of temperature and stress.

Carnivore

An organism that obtains its food energy by eating animals.

Caulking

The filling of cracks with a solid material such as plastic.

Celsius (^{0}C)

A metric temperature scale on which the freezing point of water is 0 degrees and the boiling point of water is 100 degrees. The formula for converting a Celsius temperature to Fahrenheit is $^0C=5/9\ (^0F - 32)$.

Circuit

The complete path traveled by and electric current.

Circuit Breaker

An automatic switch which breaks the circuit when too much electric current is flowing. It is similar to a fuse, but can be reused or reset.

Coal

A solid, combustible, organic hydrocarbon formed by the decomposition of vegetable material without free access to air.

Cogeneration

Using industrial waste heat to generate electrical power, thus saving energy from other sources.

Condensation

The change from gas to liquid.

Conductor (Electrical)

A material capable of carrying an electrical current.

Conservation of Matter and Energy (Law of)

The total amount of energy and matter in the universe remains constant.

Conserve

To manage or use wisely.

Consumers

(1) A person or thing that consumes; specifically, a person who buys goods or services for his/her own needs. (2) Organisms that get their energy by eating other organisms; the second trophic level on an ecological pyramid.

Conversion

The process of altering the physical or chemical nature of a substance. Processes such as cracking and polymerization can produce increased quantities or qualities of substances from basic fuel. Also, conversion can refer to the use of one energy source to produce another, such as gas used to produce electricity.

Cubic Foot (cu. ft.)

The volume of a cube, the edges of which are one foot in length. The most common unit of gas volume. The amount of gas required to fill a volume of one cubic foot under standard conditions of temperature, pressure and water vapor.

D

Decibel (db)

A unit used for measuring the intensity of sounds.

Demand, Electric

The requirement for electric power to be delivered by a system at a given instant, or averaged over any designated period of time, expressed in kilowatts or other suitable units.

Direct Current (DC)

An electric current that flows in only one direction through a circuit, as from a battery.

Distribution

The act or process of distributing electric energy from convenient points on the transmission or bulk power system to the consumer.

E

Ecology

The interrelationships of living things to one another and to their environment or the study of such interrelationships.

Electric Current

A flow of electrically charged particles along a conductor.

Electric Energy

The energy associated with electric charges and their movements. Measured in watt hours or kilowatt hours. One watt hour equals 3600 joules or 860 calories.

Electricity, Current

The flow of charged particles (electrons) through a conductor.

Electricity, Static

Free charged particles (electrons) not in motion.

Electron

A subatomic particle with a negative electrical charge, a small diameter and a mass 1/1837 that of a proton. Every atom consists of one nucleus and one or more electrons.

Energy

In scientific terms, the capability or capacity of doing work.

Energy Conservation

The practice of extending the useful life of the earth's energy resources through wise and efficient management.

Entropy

A measure (thermodynamic) of disorder or unavailability of energy. A highly ordered system has a small value of entropy; a highly disordered system has a large value of entropy. Any use or conversion of energy irreversibly degrades its entropy, resulting in less energy available of the same quality.

Environment

The sum of all external conditions and influences affecting the life, development, and ultimately, the survival of an organism. Every thing that affects a living organism.

Evaporation

The gradual change from liquid to gas (or vapor) in which molecules escape from the surface of the liquid. It is usually distinguished from boiling, where the change from liquid to gas occurs at a temperature where the vapor pressure equals the external pressure and bubbles form.

F

Fahrenheit

The temperature scale in which the freezing point of water is 32 degrees and the boiling point of water is 212 degrees. The formula for converting a Fahrenheit temperature to Celsius is $^0F = 9/5(^0C + 32)$

Fission

The splitting of a heavy atom into two parts. This splitting releases large amounts of energy and one or more neutrons.

Food Chain (Food Web)

A sequence of organisms, including producers, herbivores, and carnivores, through which energy and materials move within an ecosystem.

Fossil Fuels

Coal, oil, natural gas, and other fuels originating from geologic deposits of ancient plant and animal life. These fuels depend on oxidation for release of energy.

Fuel Cell

A device in which fuel and oxygen are combined to produce chemical energy that is converted directly into electrical energy.

Fusion, Nuclear

A nuclear reaction involving the combination of smaller atomic nuclei into larger ones with the release of energy. This process is also called a thermonuclear reaction because of the extremely high temperature required to initiate it.

G

Gasification

The conversion of a solid fuel, such as coal, to a gas. The gas can then be used as a source of heat to produce electric power, or can be broken down into liquid fuels such as gasoline.

Gasoline

A liquid mixture of light hydrocarbons produced by refining ("cracking") crude oil. Used chiefly as a fuel in internal-combustion engines.

Geiger Counter

An electrical device used to measure the intensity of gamma or beta radiation from radioactive materials.

Generation

(1) The act or process of producing electric energy from other forms of energy. (2) The amount of electric energy so produced.

Geothermal Energy

The heat energy available in the earth's subsurface, extracted from three basic sources: (1) steam, (2) hot water, and (3) hot rocks or near-surface intrusions of volcanic molten rock.

Greenhouse Effect

The heat effect of the atmosphere upon the earth. Light waves from the sun pass through the air and are absorbed by the earth. The earth then reradiates this energy as heat waves that are absorbed by the air, specifically by carbon dioxide. The air behaves like glass in a greenhouse, allowing the passage of light but not of heat. Thus, many scientists theorize that an increase in the atmosphere concentration of CO_2 can eventually cause an increase in the earth's surface temperature. Greenhouse effect also means a method of using solar radiation to warm underheated areas.

H

Habitat

The sum total of environmental conditions of a specific place that is occupied by an organism, a population or a community.

Heat

Molecular kinetic energy transferred from one object to another or obtained by conversion from another form of energy (as in conversion from electrical or chemical energy). Heat is usually measured in calories, but in space by the British Thermal Unit (BTUs).

Heat Energy

Energy that causes an increase in the temperature of an object, or changes the object from solid to liquid or from liquid to gas.

Herbivore

An organism that eats plants to obtain food energy.

Hydroelectricity

Electric energy produced by water-powered turbine generator.

Hydroelectric Plant (Conventional)

A hydroelectric power plant which utilizes streamflow only once as the water passes downstream. In this respect it differs from the pumped-storage plant which recirculates all or a portion of the streamflow in the production of power.

Hydroelectric Plant (Pumped-Storage)

A hydroelectric power plant which recirculates all or a portion of the streamflow in the production of power.

Hydropower

Power produced by falling water.

I

Insulation

Any material that provides a high resistance to the flow of heat, sound or electricity from one surface or area to another.

J

Joule

A metric unit of work or energy; the energy produced by a force of one newton operation through a distance of one meter. Equivalent to one watt second. An exajoule is equal to 10^{18} watts; estimated conventional gas resources are said to equal 10,500 exajoules.

K

Kilowatt (kW)

A unit of power, usually used for electric power (equal to 1000 watts), or to energy consumption (at a rate of 1000 joules per second). Roughly, a power of 1 kW is capable of raising the temperature of a pound (pint) of water 1^{0}F in one second.

Kilowatt-Hour (kWh)

The amount of work or energy delivered during the steady consumption of 1 kilowatt of power for a period of one hour. Equivalent to about 853 calories of heat energy.

Kinetic Energy

Energy possessed by objects in motion.

L

Light Energy

The kind of energy that travels as visible radiation. For example, photons.

Load

The power and energy requirements of users on the electric power system in a designated area or the amount of power delivered to a given point.

M

Mechanical Energy

The energy of motion used to perform work.

Megawatt (MW)

A unit of electrical power equal to 1000 kilowatts or one million watts.

Microwave

In general usage, microwaves refer to electromagnetic waves whose lengths are sufficiently short to exhibit some of the properties of light. Microwaves are used in point-to-point communications because they are easily concentrated into a beam. Frequencies of more than 1000 megahertz are usually considered to be microwave frequencies.

Motor

A machine which converts electrical energy into mechanical energy or which does work.

N

Natural Gas

An odorless, colorless, tasteless, non-toxic, clean-burning fossil fuel, natural gas is largely CH$_4$ (methane), a naturally occurring hydrocarbon that can also be produced synthetically as by coal gasification. At times it contains ethane, propane, butane, helium, and hexane.

Neutron

An uncharged elementary particle that has a mass nearly equal to that of the proton. Present in all known atomic nuclei except the hydrogen nucleus, neutrons are the particles that sustain a chain reaction in a nuclear reactor.

Non-Renewable Resources

Depletable energy resources such as the fossil fuels - coal, gas, and oil.

Nuclear Energy

Energy that can be produced by changes in the nucleus of an atom as by fission of a heavy nucleus or by fusion of light nuclei into heavy ones with accompanying loss of mass.

Nucleus

A dense central core of the atom in which most of the mass and all of the positive charge is concentrated.

Nutrient

Elements or compounds essential as raw materials for organism growth and development. For example, nutrients are carbon, oxygen, nitrogen, and phosphorus. Classes of nutrients in food are carbohydrates, fats, proteins, vitamins, minerals, and water.

O

Oil

Any of the various kinds of greasy combustible substances obtained from animal, vegetable, and mineral sources. Oils are liquid at ordinary temperatures and soluble in certain organic solvents, but not in water. Synonym: petroleum.

Ohm

The unit of measure of electrical resistance. One volt will force a current of one ampere through a resistance of one ohm.

P

Peak Load

The maximum amount of power delivered during the stated period of time. The term is sometimes used to describe that portion of the load above the base load.

Petroleum (Crude Oil)

A naturally occurring material (gaseous, liquid, or solid) composed mainly of chemical compounds of carbon and hydrogen. Fractional distillation yields gasoline, diesel, lubricating oil, and other products.

pH

A way of expressing both acidity and alkalinity on a scale of 0 - 14, with 7 representing neutrality, numbers less that 7 increasing acidity, and numbers greater than 7 increasing alkalinity.

Photosynthesis

The process in which sunlight falling on green plants causes carbon dioxide and water to be converted into more complex organic materials such as glucose. Thus, it is the process by which green plants convert radiant energy into chemical energy.

Potential Energy (Electrical)

The amount of voltage capable of moving an electric charge from one point to another.

Power

The rate at which work is done or energy expended. It is measured in units of energy per unit of time, such as calories per second, and in units such as watts and horsepower. If an amount of work (W) is done over a period of time (t) the power or rate of doing work is $P=W/t$.

Producers

Organisms that utilize light energy to produce usable chemical energy; i.e., plants, autotrophs. Producers are the first trophic level on a pyramid of energy.

Proton

An elementary particle found in the nucleus of all atoms. It carries a positive charge equal to the negative charge of the electron. The proton is, in effect, the positive nucleus of the hydrogen atom.

R

Radiant Energy

Any form of energy radiating from a source; i.e., sound, heat, electromagnetic waves, light, x-rays, gamma rays, etc.

Radiation

Any high-speed transmission of energy in the form of particles or electromagnetic waves.

Recycle

To process what are often waste materials (i.e., cans, glass, plastic, newspapers) in order to regain the material for beneficial human use.

Refining

A series of processes that improve the usability of a raw fuel. Substances can be separated, converted, or treated to yield desirable compounds.

REM

The unit of measurement of the dose of radiation absorbed per unit mass (adjusted for the effectiveness in causing biological change).

Resources

The estimated total quantity of a natural resource such as petroleum, natural gas, coal, wood, minerals, geothermal energy, etc.

S

Solar, Active System

Energy from the sun used to generate electricity and to produce liquid or gaseous fuels. Active solar systems include windmills, hydroelectric energy, solar thermal energy conversion, biomass, ocean thermal energy conversion, and satellite power systems.

Solar Cell (Photovoltaic Cell)

An electric cell which converts radiant energy from the sun into electrical energy by the photovoltaic process.

Solar Collector

A surface which by virtue of geometry or surface properties absorbs solar energy and imparts this energy to a heat transfer fluid which circulates through the collector.

Solar, Passive System

A means of capturing, storing , and using heat from the sun. Unlike Active systems, passive solar systems do not require the use of pumps and controls.

Solar Energy

Radiation energy from the sun falling upon the earth's surface.

Sound Energy

A type of energy in which waves are carried by the transmission of mechanical vibrations through air, water, or solids.

Steam

The vapor that forms when water is heated to the boiling point. Jets of steam are capable of driving the pistons in a piston engine or turning the blade of a turbine.

Storm Door

An additional door with an air space between it and the existing door.

Storm Window

An additional window with an air space between it and the existing window. Storm windows will cut in half the heat that passes through windows in a house.

Substation

An electrical power station which serves as a control and transfer point in an electrical transmission system.

Superconductor

A material which when cooled near absolute zero, has no electrical resistance. Superconducting transmission lines can carry electrical power without loss. Superconducting coils can store large amounts of electrical energy.

T

Temperature

The degree of hotness or coldness measured on a definite scale. Specifically, the temperature of a substance is a manifestation of the speed of molecular movement.

Thermal Energy

The total potential and kinetic energy associated with the random motions of the particles of a material.

Transformer

A device which can increase or decrease the voltage of an alternating current.

Transmission

The act or process of transporting electric energy in bulk from a source or sources of supply to other utility systems. It is done at high voltage to reduce loss.

Turbine

A rotary engine powered by a jet of steam or fluid. It can be used to power a generator for electricity production.

V

Vapor

The gaseous state of substances that are normally liquid or solid. Steam is a good example.

Volt

A unit of electrical pressure which forces electrical charges to move through conductors. One volt will force one ampere of current to move through a resistance of one ohm.

Volume

A three-dimensional space measurement. Natural gas is measured by volume (cubic feet).

W

Water Pollution

The addition of sewage, industrial, and institutional wastes or other harmful or objectionable material to water in concentration, or in sufficient quantities to result in measurable degradation of water quality.

Watt

A metric unit of power, usually used in electric measurements, which gives the rate at which work is done or energy expended. One watt equals one joule of work per second. Stated in another manner, one watt is the work done when an electrical force of one volt pushes 6 x 10^{18} electrons through a resistance of one ohm in one second.

Windmill

A machine for doing useful work utilizing the energy of wind.

Work

The transfer of force form one body or system to another. Work is performed by a force moving an object.

Notes